Materials & Methods

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AUGUST
1953

Russian Steels Today

Which Metal Form—Spun or Drawn?

New Paper Materials

How to Select Aluminum Cable Connectors

Where Plastics Are Used in Airliners

Heat Treating Gears

Photographic Inspection of Brazing

Source List of Metal Powders

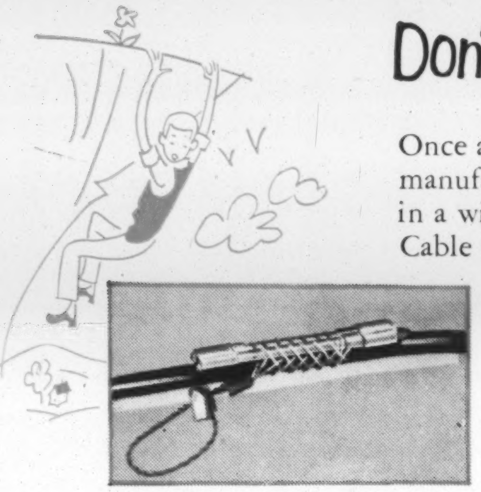
PROTECTIVE COATINGS FOR METALS
—Materials & Methods Manual No. 96

THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

ANACONDA METALS AT WORK

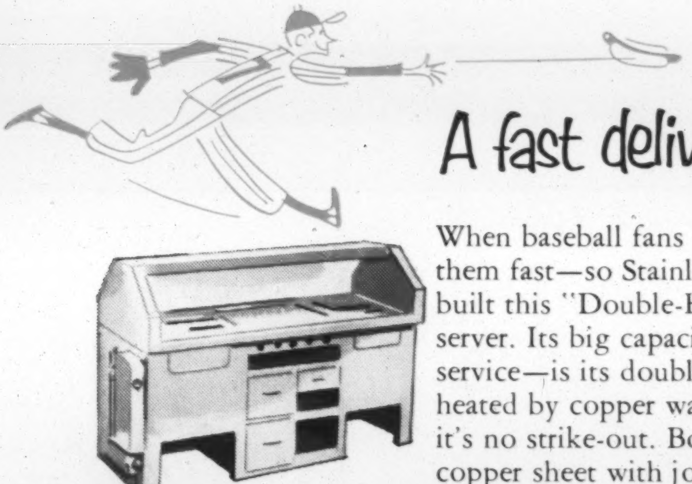
Meet the educated screw

This is a whole family of screws, known as Screwsticks, and joined head-to-toe. Insert a Screwstick in the driver, aim it at the hole—and from there on the Screwstick tightens itself to the predetermined torque, shears itself and gets its head burnished by the following screw which automatically advances itself. It's so fast that American Screw Co. of Willimantic, Conn., which uses ANACONDA Hexagon Brass Rod, refers to it as "jet propulsion".



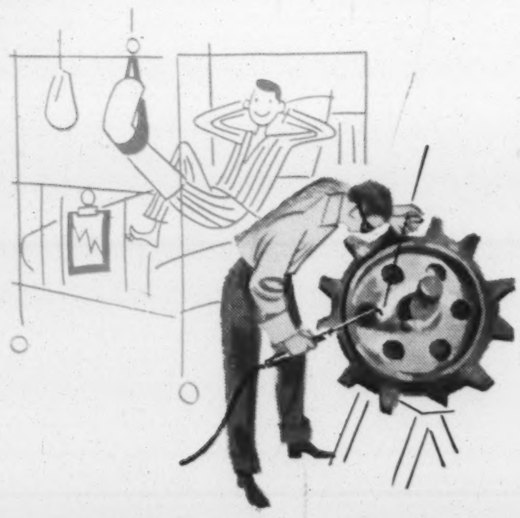
Don't lose your grip

Once a novelty trick developed by the Chinese, the manufacture of these grips is now an industry. Made in a wide variety of styles and sizes by Economy Cable Grip Co. of Norwalk, Conn., they are used to anchor suspended electric power cables and to seize the end for pulling through ducts. The harder you pull, the tighter they grip. Needless to say, the ANACONDA Bronze Cable, Everdur* Rod and Copper Tube used in their manufacture never weaken from rust.



A fast delivery...with mustard

When baseball fans want their hot dogs, they want them fast—so Stainless Alloy Fabricators of Detroit built this "Double-Header" baseball park hot dog server. Its big capacity for hot dogs—and fast service—is its double bun warmer, one at each end, heated by copper water boilers. If the water runs dry, it's no strike-out. Boilers are made of phosphorized copper sheet with joints formed by fusing the edges with a Heliarc torch. No solder used, no seams to burn open.



How to treat a fracture

A fracture often means long uselessness—but that needn't be true of machinery. Usually braze welding can make it good as new and at a fraction of the time and cost of replacing it. This fractured cast iron conveyor drive sprocket, for example, would have taken two months to replace. The Universal Welding Co., Rochester, N. Y., repaired it in only 7 hours by braze-welding with ANACONDA-997 (Low Fuming) Bronze Welding Rod. Moral: don't count the patient out before consulting your welder.

There's more to this than meets the eye

In our Technical Department you will find a range of experience that covers the entire field of copper and copper-alloy applications in the metalworking industries. If you have a problem of metal selection, we are at your service. *The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*Reg. U. S. Pat. Off. 5391

ANACONDA® the name to remember in COPPER-BRASS-BRONZE

Materials & Methods®

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Feature Articles

Russian Steels Today . . . . Carl A. Zapffe **79**
A detailed picture of what steels are being used behind the iron curtain

Which Metal Form—Spun or Drawn? . . . . John W. Lengbridge **87**
Unit cost comparisons show where each fits best

New Paper Materials—Properties and Uses . . . . E. E. Frazier **92**
Combinations of various nonmetallics and beater-saturation process give unique sheet material

Photographic Inspection Spots Defective Brazing . . . . . . M. A. Slairetam **94**
Cuts production rejects and cost of airplane propellers

How to Select Connectors for Aluminum Conductors . . . . . Henry Dupre **96**
Designing or adapting connectors specifically for aluminum helps solve joining problems

Where Plastics Are Used in Air Liners . . . . Harold H. Rosenbaum **100**
Careful materials selection takes advantage of properties of a variety of plastics

Heat Treating Gears to Meet Rigid Requirements . . . . . . Ralph Spagnola **102**
Forged steel gears for helicopters undergo closely controlled carburizing treatment

Materials at Work **104**
Molded and Sintered Nylon Gears • Glass Lined Smoke Stack

New Test for Drawability . . . . C. B. Buker and J. R. Speer **156**
Fast, simple method overcomes limitation of older tests

Report on the Materials Show **13**
A message from the publisher and editor of MATERIALS & METHODS

Materials & Methods Manual No. 96

Protective Coatings for Metals . . . . John B. Campbell **109**

Engineering File Facts

Granular Powders for Powder Metallurgical Applications (No. 258) **127**

Departments

The Materials Outlook . . . **3**
News Digest **6**
Materials Briefs **11**
New Materials & Equipment . **133**
Meetings & Expositions . . . **210**
Materials Reports **212**
Book Reviews **218**
Manufacturers' Literature . . **225**
Advertisers and Their Agencies **240**
The Editor's Page **242**

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From small discs to heavy forgings

...Incoloy baskets take the load

and the heat up to 1850° F.

This worker at the L. & R. Heat Treating Co., is about to place a heavy forging die in a batch furnace to soak for 8 hours at 1800° F. The Incoloy basket has been in this rugged service for nine months and it's still in shape for more of the same.

Basket fixtures for heat treating shops not only have to handle a wide variety of sizes ranging from small pieces to heavy forgings, but they must go through a variety of heat treating cycles.

Naturally, for such rugged duty you would need a really strong metal.

The L. & R. Heat Treating Company in Newark, New Jersey, found just the material they needed in Incoloy®, new companion alloy to Inconel®.

As a matter of record, the Incoloy fixtures have outlasted fixtures of competitive alloys and are still in service.

For instance, this Incoloy basket, holding a heavy forging die, is about to enter a batch furnace where it will soak for 8 hours at 1800° F. But that's only one of the jobs it's required to perform.

Next it might be called for use in a heating cycle involving quenching in oil, or for a simple air cooling job. It's already been in service for nine months. And it's still in good condition for any number of jobs involving temperatures up to 1850° F.

The fabricators of the Incoloy baskets, Basket Manufacturing Company, Newark, N. J., found that this new member of the Inco family was readily fabricated into heat treating equipment of all types. It is both workable and weldable for maximum flexibility in efficient design.

If you would like to learn more about Incoloy, write for your copy of "Preliminary Report on Incoloy."

It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

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TRADE MARK

Inco Nickel Alloys

Incoloy... for Heat-Resisting Applications

The Materials Outlook

Titanium ingots claimed to be more homogenous than conventional arc melt ingots and containing less carbon than induction melt titanium will be made by a melting process new to commercial use. The process uses a titanium electrode in place of carbon, and a water-cooled copper crucible. In addition to making possible alloys with better machinability, weldability and impact strength, the process is expected to increase the yield from sponge.

The critical shortage of titanium is under continuing study by government and industry. Melting capacity still far exceeds sponge production capacity. Current aim is to boost this year's expected sponge output of 3400 tons to more than 18,600 tons by 1956. Efforts are also being made to increase the amount of titanium scrap that can be recovered and used.

A new titanium alloy containing aluminum and tin and having a minimum yield strength of 110,000 psi has been developed. The alpha type alloy is expected to be useful for engine parts and airframes because of its greater weldability compared to conventional titanium alloys.

Two new unsaturated polyester-styrene resins especially designed for matched metal die molding of reinforced plastics are available. They feature high strength retention at elevated temperatures, and are adapted to fast molding cycles. The stronger and more rigid of the two has a torsional modulus of 370,000 psi at 100 F, 210,000 at 210 F and almost 90,000 at 265 F.

A new method of forming large aluminum sheet structures has been revealed. Shot peening, a process with a variety of industrial applications, was found to be the only feasible way to produce chordwise curvature in the 32-ft wing skin, made of 75ST6 alloy, for the Lockheed Super Constellation. Although only one side of the metal is peened, the result is compressive stresses in both surfaces and it is believed that these will help prevent stress corrosion.

Although Russian stainless steel technology is not considered particularly impressive, chromium-manganese-nickel steels, now gaining much interest in this country, have been standard in Russia for some years. The steel recently introduced in this country has 16 chromium, 16 manganese and 1% nickel. In one alloy designed for similar applications the Russians have kept their nickel content at about 4% and use about 13 chromium and 9% manganese. This is what metallurgists here would like to do if they could get the higher nickel OK'd. See p. 79 for a complete rundown on Soviet standard steels.

(Continued on page 4)

The Materials Outlook *(continued)*

Wire insulated with silicone rubber has now been approved by the Underwriters' Laboratories for use in devices and appliances operating at temperatures up to 390 F. The flexible silicone coating, ranging in thickness from 15 to 77 mils, is covered with a lacquered glass braid with high abrasion resistance. . . . The silicones are still too high in cost for ordinary applications. But it looks like the favorable insulating properties of other synthetic rubbers will shortly edge natural rubber out of wire and cable insulation entirely, barring an unexpected drop in the price of natural rubber.

Steels with higher molybdenum content than has been available recently are now being produced as a result of the government's action in freeing this metal from all controls. By the end of the year Climax Molybdenum is expected to be producing the metal at a rate about 90% above that of last year.

A matte finish colored porcelain enamel, designed specifically for chalkboards, is now being made by two producers. The ceramic is fired on 18-gage steel which is then backed with hardwood or plywood about 5/16 in. thick. The ceramic has abrasive particles suspended throughout so that it cannot become glossy with use. Although it costs about 25% more than conventional slate chalkboard, it can be made in several colors (green is favored) and is expected to prove much more durable. . . . The porcelain enamel industry expects a considerable growth in applications for porcelain-enameled aluminum. A major frit producer has just obtained a license to produce and sell the aluminum frit developed by DuPont. However, present and most pending applications are confined to the architectural field.

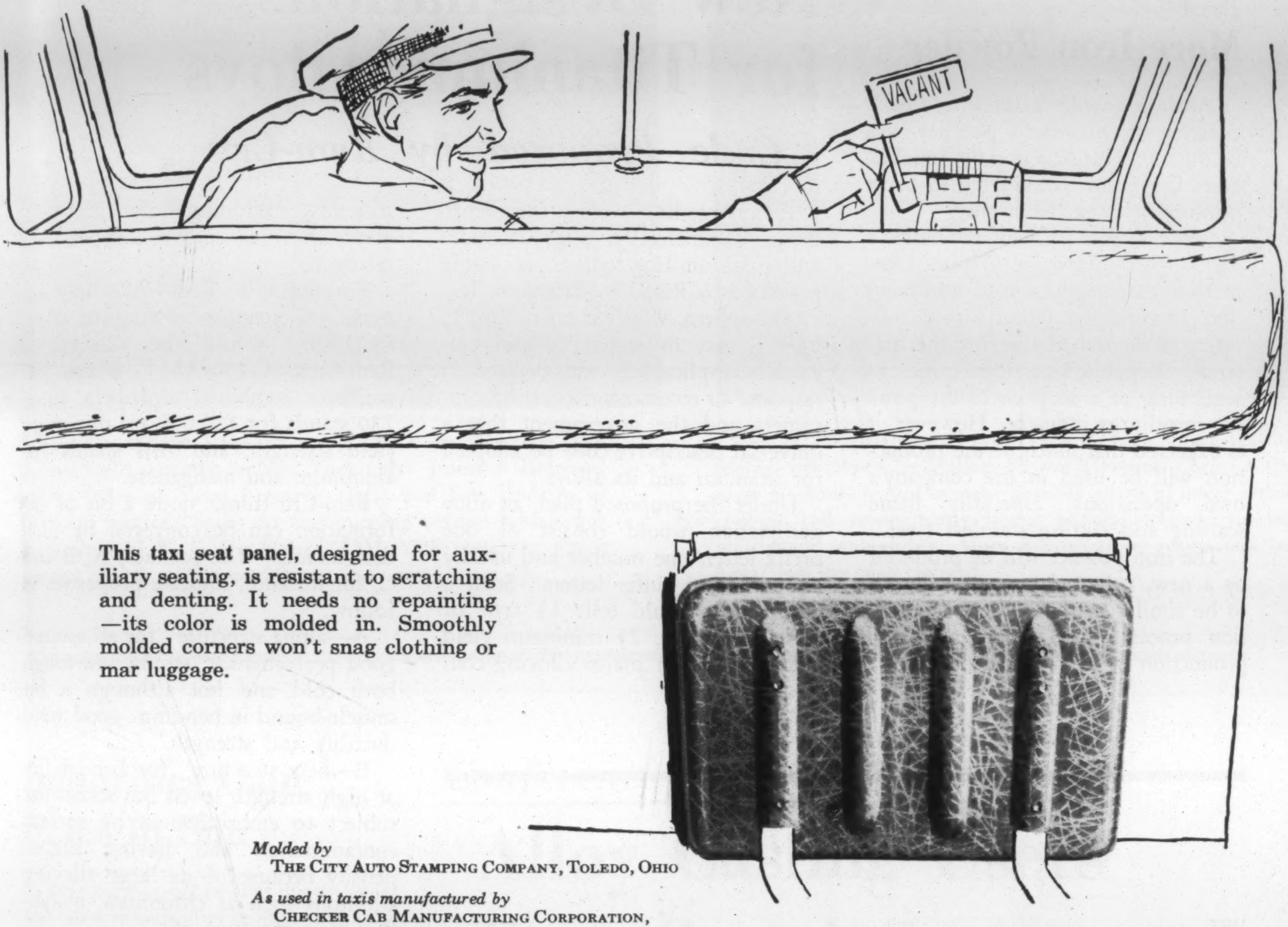
Dacron, the polyester fiber which has caused quite a commotion in the fashion field, is now being used for electrical insulation. In addition to its well-known chemical resistance and low moisture pickup, it offers strength and heat resistance. It can be made tougher than asbestos and is easy to apply as an insulating cover.

Look for at least temporary price rises in both synthetic and natural rubber when the government-owned synthetic rubber plants are sold to private industry. A rise of three cents a pound for synthetic has been forecast, and the predicted increase in the price of natural rubber ranges from 3 to 7 cents.

A voluntary industry standard for general purpose vinyl film is now official. . . . Development of similar standards is being undertaken by fabricators of rigid polyvinyl chloride.

A new method of connecting electronic tubes and components to printed circuits has been developed. Small 3-contact molded blocks containing one or two circuit elements are pressed against the circuit by means of springs that are extensions of the tube socket contacts. No soldering is necessary, and repairs and replacements are claimed to be easily done.

Another outstanding use of molded polyester resins and Fiber·Glass



This taxi seat panel, designed for auxiliary seating, is resistant to scratching and denting. It needs no repainting —its color is molded in. Smoothly molded corners won't snag clothing or mar luggage.

Molded by
THE CITY AUTO STAMPING COMPANY, TOLEDO, OHIO

As used in taxis manufactured by
CHECKER CAB MANUFACTURING CORPORATION,
KALAMAZOO, MICHIGAN

This Checker Cab auxiliary seat panel is still another example of the wide possibilities in design and material properties offered in moldings of Plaskon Polyester Resins and Fiber·Glass.

Whenever you specify these materials you benefit in superior moldings . . . superior strength, lightness and durability. Moldings of L·O·F Plaskon Polyester Resins and Fiber·Glass are unexcelled in dimensional stability, flexural strength and resistance to common solvents and weathering.

In addition, Fiber·Glass roving, treated by the Garanizing process, gives increased wettability for a higher degree of translucency and added strength in the moldings. Moreover, Plaskon Polyester Resins have a longer flow period with a rapid gel time and give better surface characteristics to your finished product.

For uniform quality of ingredients . . . for the benefits of L·O·F Fiber·Glass Garanized roving . . . for one reliable *single source* for all these materials, check with Plaskon. For information or technical assistance, write today to Plaskon Division, Libbey·Owens·Ford Glass Co., Dept. 483, Toledo 6, Ohio.

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MATERIALS ENGINEERING News Digest

Republic Plans More Iron Powder

An iron powder plant with a daily capacity of 50,000 lb per day will be built in Toledo, Ohio by Republic Steel Corp. and is expected to be in production a year from now.

Republic is the first of the nation's major steel companies to plan commercial scale production of iron powder. In view of a recent survey indicating a limited market for the material, Republic's action came as something of a surprise to the powder metallurgy industry. However, it is expected that much of the production will be used in the company's own operations, especially flame scarfing and cutting stainless steel.

The iron powder will be produced by a new, patented process, believed to be similar to the hydrogen reduction process most widely used for production of high-grade material.

New Designations for Titanium Alloys

Code Proposed by Rem-Cru

A new coding system for identifying commercially pure titanium and titanium-base alloys is being proposed by Rem-Cru Titanium, Inc.

The system, which it calls "simple, logical, easy to remember and universally applicable," was devised in response to recommendations by consumers and the government that a universal descriptive code be adopted for titanium and its alloys.

Under the proposed plan, an alloy designation would consist of one prefix letter, one number and usually one or more suffix letters. Such a designation would tell: 1) type of crystal structure, 2) minimum yield strength, and 3) major alloying constituents, excluding interstitial elements such as carbon, oxygen and nitrogen.

For example, Rem-Cru's 4-aluminum, 4% manganese forging alloy, RC-130B, would be designated Rem-Cru C-130-AM, where *C* means a combined alphabeta alloy, *130* stands for 130,000 psi minimum yield strength, and *AM* stands for aluminum and manganese.

Rem-Cru thinks quite a bit of information can be conveyed by such designations. The prefixes, A, B and C, for instance, indicate properties as follow:

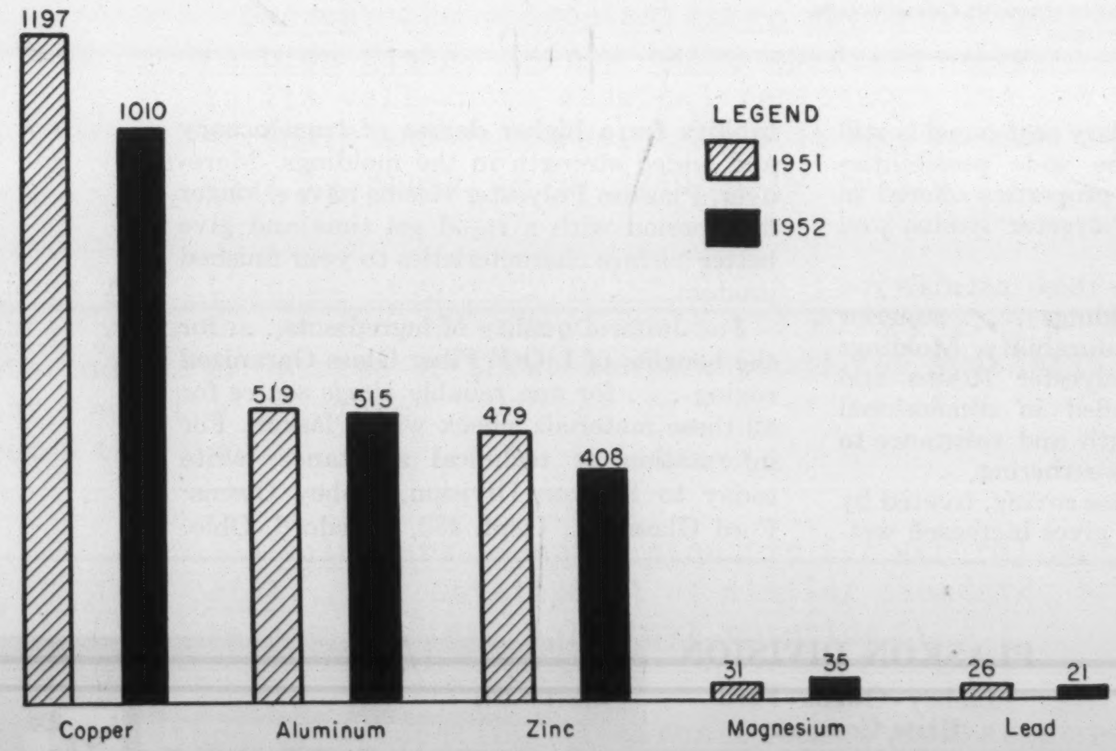
A—alpha structure "for all-around good performance; strong and tough both cold and hot although a bit muscle-bound in bending; good weld ductility and strength."

B—beta structure "for bendability at high strength levels but somewhat subject to embrittlement by surface contamination and having higher density because of its large alloying additions such as chromium, molybdenum, manganese, etc."

C—combined alpha-beta structure for compromise performance: "good bend and strength when cold but weak above 700-800 F; inclined to be brittle after welding; excellent forgeability."

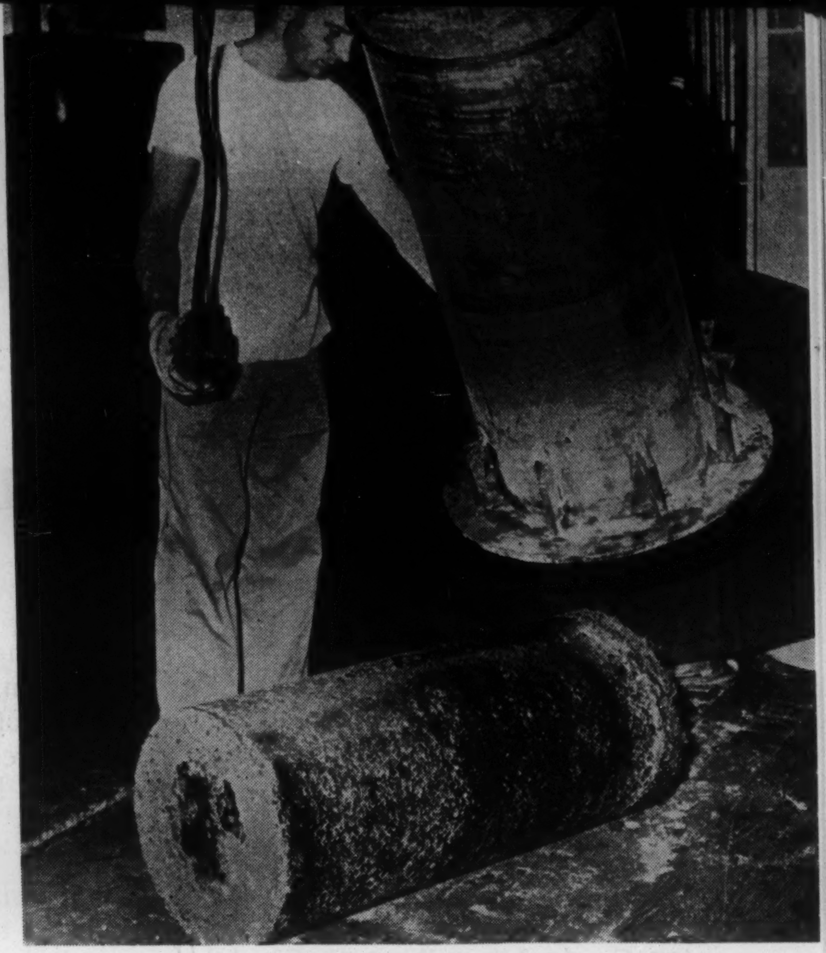
Yield strength was picked as a particularly significant property for titanium "because its yield strength is closer to its ultimate tensile strength than is the case for most metals. Moreover, virtually all applications for titanium are based on its yield strength and neither cold work nor heat treatment is customarily used to enhance the yield strength."

The letters following the strength figure are intended to indicate major alloying elements in order of decreasing amounts. Provided the influence of the various alloying elements on titanium is known, these letters furnish additional information on the properties of the alloy.



Nonferrous Castings Drop **Last year's total shipments of nonferrous castings were 1993 million pounds compared to 2248 in 1951, a drop of 11%. The chart compares castings shipments, in millions of pounds, of the major nonferrous metals and their alloys for the two years. Figures were supplied by the U. S. Dept. of Commerce.**

They took the kickoff at the first Basic Materials Conference held recently in New York City. Julius J. Harwood of the Office of Naval Research (left) and Eric Hodgins of *Fortune* (center) spoke at the opening session which was moderated by T. C. Du Mond, M&M editor (right). For a special report on the conference and show, see p. 13.



This titanium ingot was made by a new arc melting process developed by Mallory-Sharon Titanium Corp. A titanium electrode is said to make possible alloys of lower carbon content and consequently better impact strength, machinability and weldability. More homogeneous ingots and less metal loss are also claimed.

Impurities Gain Place in Sun

Impurities—which for many years has been just another name for trouble—are now becoming a science.

Impurities in engineering materials started their long history by being ignored when they shouldn't have been.

Then the research men found out how to measure them, and strong competition developed to see how many of them could be completely eliminated.

In recent years, scientists have achieved some remarkable results by a compromise—controlling the amount and distribution of impurities—as in transistors and luminescent materials.

Several weeks ago the General Electric Research Laboratory elevated this whole business to the stature of a science by holding a three-day symposium on "impurity phenomena". In addition to engineering materials, the discussion included such varied topics as photographic films and rainmaking.

Conference Hears:

Alloy Casting Users Face Restrictions

Users of high alloy castings must be aware of the supply situation as well as the technical characteristics of these materials.

The significance of some of the limitations imposed by the National Production Authority in an effort to conserve nickel were explained by E. A. Schoefer, executive vice president of the Alloy Casting Institute, at a recent conference at the Harbor Island, N. C., corrosion testing station of International Nickel Co., Inc.

Downgrading of heat resistant alloys by the NPA means that castings containing more than 37% nickel can no longer be produced except for unusual service, he said. Where HX (67 Ni, 17 Cr), HW (60 Ni, 12 Cr) and HU (39 Ni, 19 Cr) types were previously used, type HT (35 Ni, 15 Cr) is now being used. This alloy is the maximum-nickel type permitted for highly stressed parts exposed to carburizing or other such atmospheres at all temperatures above 900 F, and for highly stressed parts exposed to oxidizing or neutral atmospheres above 1600 F. Parts subject to moderate stress and no thermal fatigue can be made in the HT grade only if the temperature exceeds 1900 F. These limitations have caused increased use of types HH (25 Cr, 12 Ni), HF (21 Cr, 9 Ni) and HB (19 Cr, 2 Ni).

Mr. Schoefer also stressed the importance of specifying alloy castings by ACI designations. Although castings are made with chemical compositions similar to the wrought grades, he pointed out, there are significant differences in the ranges for the major and minor alloying elements. AISI designations apply specifically

(Continued on next page)

to wrought materials only.

Another problem discussed at the conference was the need for a cast alloy that will retain high strength when exposed continually to temperatures of 2000 to 2200 F. Norman A. Matthews of American Brake Shoe Co. framed the problem in terms of three basic questions:

1. Should some ductility be sacrificed for hot strength?

2. What is the minimum usable creep strength for a typical furnace part?

3. How much can users of high alloy cast parts pay for increased hot strength?

He noted that the NA22H alloy (27 Cr, 50 Ni, 5 W, 0.50 C) developed by the National Alloy Div. of the Blaw-Knox Co. is a start in the direction of solving the problem. Research being sponsored by ACI at Battelle Memorial Institute, he said, is aimed at developing an alloy with strength characteristics similar to those of NA22H but containing smaller amounts of strategic elements.

P.W. Litchfield:

Must Plan Now for Enough Rubber

A program intended to keep the fabricator and user of rubber parts from being squeezed by interrupted production during the approaching transfer of synthetic rubber plants from government to private ownership has been outlined by P. W. Litchfield, Chairman of the Board, Goodyear Tire & Rubber Co.

Emphasizing that the war-born synthetic rubber industry is vitally essential to America's security and progress, he said the following steps are necessary to protect the nation's interests:

1. That full production schedules be maintained between now and the time the synthetic plants are finally and officially transferred to private ownership and operation.

2. That we begin now to create a reserve stockpile of at least 200,000 tons of synthetic rubber, building from excesses beyond current needs.

Need Both

The first step is essential, he said, to provide enough synthetic rubber for our needs and to keep the price of natural rubber within reasonable bounds.

The stockpile is needed for security reasons, accentuated by the possibility of an interruption of production levels during the change of ownership, possible as long as two years.

"I see no reason why these steps cannot be taken in stride and I believe our government and the rubber industry are obligated to take them in the public interest," he said.

He pointed out that some 900 fabricators of rubber products, large and small, and their millions of customers are directly involved in the forthcoming transfer of the nation's 29 government-owned synthetic rubber plants, and should be protected against any interruption of the flow of their raw materials.

Plan Now

"Hence, the transition period which may be protracted, is a matter of great national concern. Now is the time to do the planning which will carry us over these rough spots if they should develop."

While the current situation is "comfortable", with supplies of natural and synthetic in balance with demand, and at reasonable prices, we must not be lulled into a sense of false security, he warned, citing three factors which must be borne in mind:

1. The current Communist agression in Indo China which threatens the security of the rubber growing areas of Southeastern Asia.

2. The approaching disposition of government-owned synthetic plants to private corporations.

3. The steadily increasing demands for rubber. It is not unreasonable to expect that by 1960, these

(Continued on page 160)

What They Said . . . .

FISSIONABLES ". . . There should be no limitation on the amount of fissionable material which the government may sell or distribute to a licensee for nonmilitary use after military needs have been met."—*National Assn. of Manufacturers, June 15, 1953.*

DESIGN "All materials problems cannot be completely resolved in the design stage, but those that cannot should be reduced to secondary importance and greatly simplified by this prior attention."—*J. W. Frazier, Hughes Aircraft Co., June 18, 1953.*

AUTOMATION "The use of automation in our manufacturing plants is a trend which has started and which we feel will continue and expand. . . . We are certain that increased management attention, engineering thought, and coordination will keep this trend going and extend it substantially for the maximum benefit to all. . . . The future looks promising and there is no industry which can afford not to consider the possibilities."—*D. S. Harder and D. J. Davis, Ford Motor Co., Mar. 25, 1953.*

THE LAB "Whether your company still is in existence and making a profit 10 or 20 years from now, or what kind of product it will be making or selling then, is more likely to be determined by what happens in the laboratory than by what happens in the accounting office, in the sales office, or even in the halls of Congress or the White House."—*Dr. Lee A. DuBridge, President, California Institute of Technology, May 1953.*

CHOICE "Never before have the materials engineer, designer or production man had such a choice of materials to work with for any given application."—*Julius J. Harwood, Office of Naval Research, June 16, 1953.*

Materials BRIEFS

It's Kitchen On A New England housewife is selling sheets of Teflon plastic by mail. She says they are wonderful to use in baking; you don't need any utensils and you save ingredients since the dough won't stick to Teflon.

Getting Lead Out Stalpath, a steel - aluminum - plastic sheath, is gradually replacing lead for sheathing telephone cable.

Octopus Welder A complicated mass of machinery, resembling to some extent an octopus, is being used to make 62 simultaneous welds at the rate of 744 welds a minute. It was designed especially for a New York firm which manufactures subway grating.

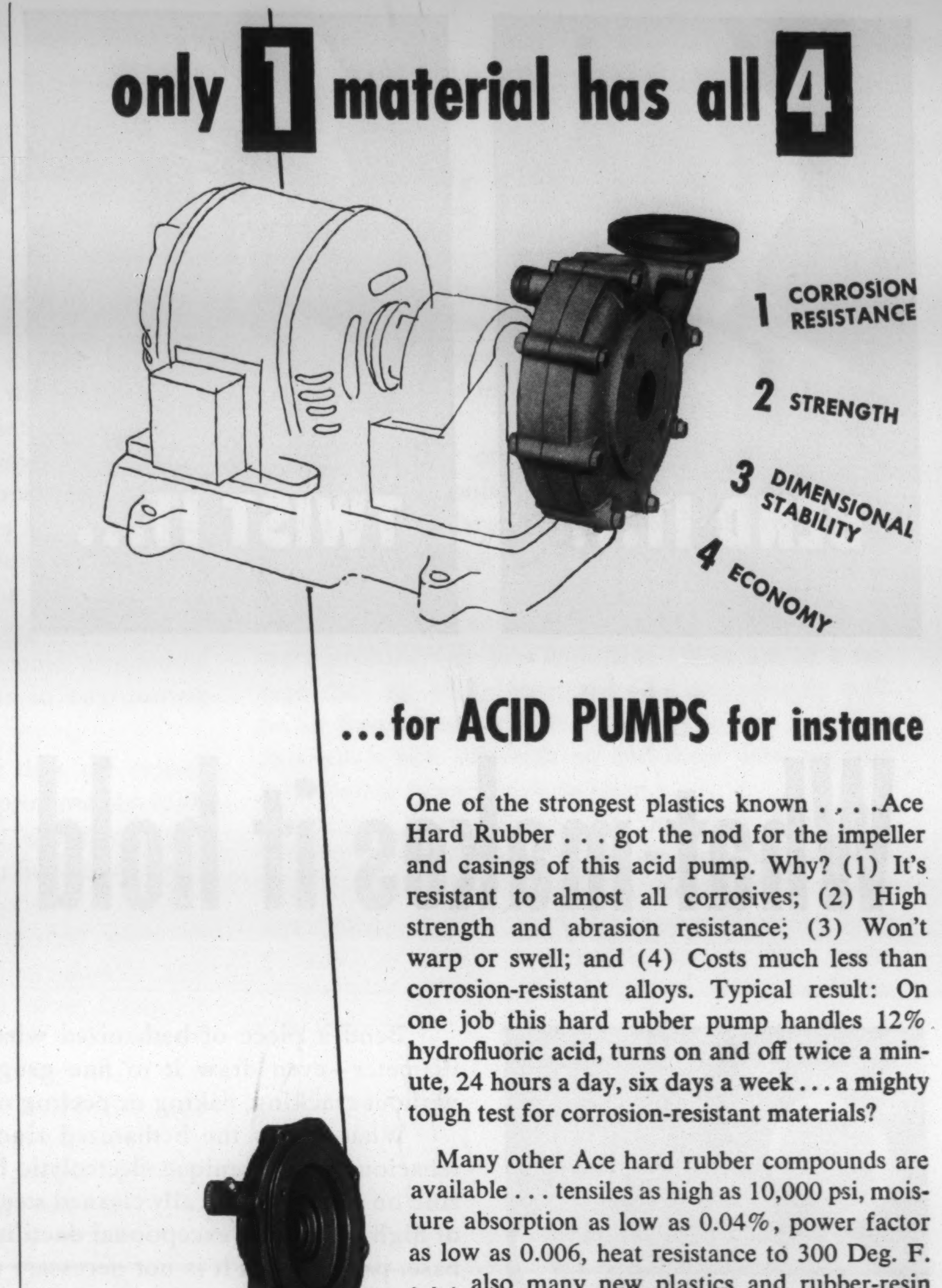
More But Less In 1941, 47,000 tons of tin were used in containers. Last year less than 28,000 tons were used, even though 18 billion more cans were produced. According to a leading can producer, research in tinplate conservation has saved the U. S. 257,000 tons of tin since 1941.

Synthetic Sweat A leading instrument manufacturer brews synthetic perspiration on the side. It is used in their research program on the effects of perspiration on finishes for metals.

Solder Edged A new technique of fastening mechanically the wire banding on armatures threatens to edge solder out of the picture. Probably it will not be missed for its relatively low strength, low melting point and high density make it structurally undesirable in this time-honored application.

Nicotine More fuel for the cigarette copywriters has been provided with the discovery that restricting the manganese content of the soil decreases—and restricting the boron content of the soil increases—nicotine content in tobacco plants.

Sterilization Various packaging materials such as iron, copper, lead and plastics are being irradiated to determine by how much radiation dosages must be increased to sterilize drugs and foods inside their packages.



only 1 material has all 4

1 CORROSION RESISTANCE

2 STRENGTH

3 DIMENSIONAL STABILITY

4 ECONOMY

...for ACID PUMPS for instance

One of the strongest plastics known . . . . Ace Hard Rubber . . . got the nod for the impeller and casings of this acid pump. Why? (1) It's resistant to almost all corrosives; (2) High strength and abrasion resistance; (3) Won't warp or swell; and (4) Costs much less than corrosion-resistant alloys. Typical result: On one job this hard rubber pump handles 12% hydrofluoric acid, turns on and off twice a minute, 24 hours a day, six days a week . . . a mighty tough test for corrosion-resistant materials?

Many other Ace hard rubber compounds are available . . . tensiles as high as 10,000 psi, moisture absorption as low as 0.04%, power factor as low as 0.006, heat resistance to 300 Deg. F. . . . also many new plastics and rubber-resin blends. All Ace compounds are tailor-made to fit the job . . . never *over*-designed. That's why Ace is the *only* material that meets all four big requirements for parts like acid pumps.

and here's a 5th

Hard rubber sleeve provides electrical insulation as well as mechanical and chemical strength in this coupling for electroplating agitator.

80-pg. Ace handbook free to design engineers.

ACE® rubber and plastic products

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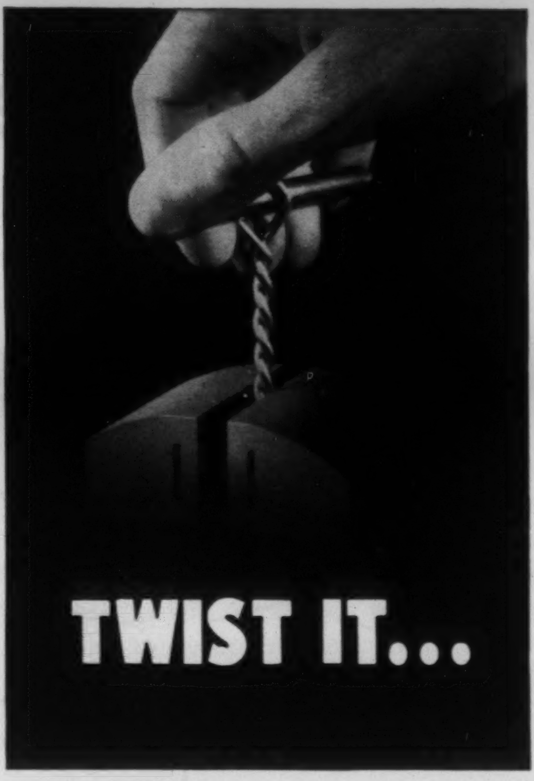

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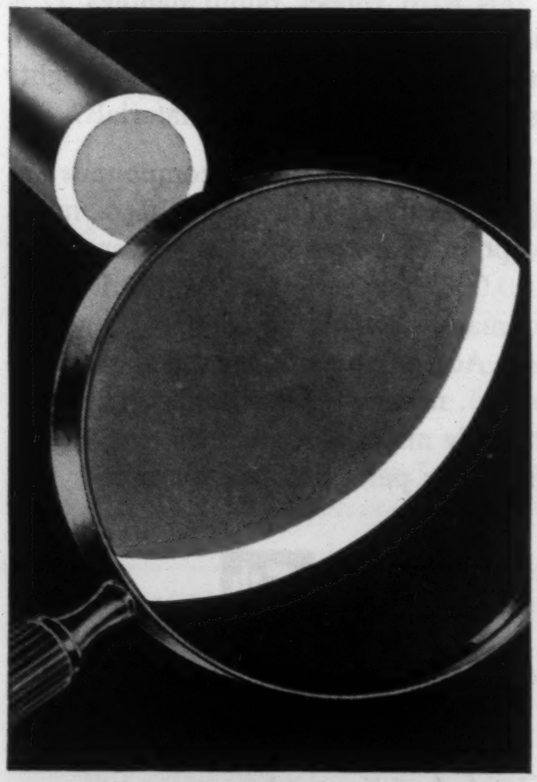

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BETHLEHEM STEEL

BETHANIZED WIRE

All Participants Agree:

Materials Show A Rousing Success

At 10:30 a.m. on Monday, June 15, 1953, a relatively small group of people waited expectantly for the doors of Grand Central Palace in New York to open and admit the first visitors to the First Exposition of Basic Engineering Materials. The group included representatives of the show management firm of Clapp & Poliak, Inc., personnel manning the booths of some 84 exhibitors, and a few others like ourselves who had a strong hope for the success of the venture. All were united in the belief that the need was great for one industrial exposition which would allow technical men to become acquainted with all of the latest developments in engineering materials.

Their faith was justified. By the time the exposition closed on Friday, June 19, approximately 9,000 high-level engineers had attended the exposition. This is a substantial attendance for a first show which is not open to the public. More important, exhibitor and attendee alike were highly satisfied with the show. Those attending remarked frequently that they were highly in favor of the show being restricted to engineering materials and not cluttered up with a variety of exhibits which had nothing to do with their basic interests. The exhibitors were nearly unanimous in their views that visitors to the show were all of extremely high calibre and were vitally interested in what was being shown.

One exhibitor reported he had had so many good prospects visit his booth on the first day of the exposition that he felt his entire expenditure to have been more than justified. Others expressed similar approval of the quality of the attendance.

Most of the engineers whose reactions to the show were made known agreed that the types of exhibits were helpful to them and were especially pleased that most important classes of materials were represented. Those attending the exposition came from all parts of the country, with rather large delegations coming from the West Coast.

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Also highly pleasing was the attendance at the Basic Materials Conference held at the Hotel Roosevelt during the middle three days of the same week. More than 400 engineers registered for the conference, most of them for the entire 3-day program. That the conference goers were interested might best be summed up by the remarks of one seasoned participant in technical conferences, who observed: "There was less shuffling about, fewer members of the audience leaving during the talks and less noise than in any other conference I ever attended." This has been interpreted to mean that the audiences were extremely interested in the subjects and in the men who discussed them.

It is a matter of record that many of the men attending the conference were strong in their demands that similar conferences be held annually.

Even though we on MATERIALS & METHODS are extremely pleased with the success of both the exposition and conference, we did see some flaws which were probably obvious to others. Most are of a nature that are easily corrected and undoubtedly will be in future years. Most were due to the fact that this was a new undertaking and there were no past experiences from which to learn.

Strangely enough, one of the most frequently heard comments was that not enough of the large companies were represented in the show. A partial explanation lies in the fact that some companies have a policy of never participating in any first show. Some have already expressed regret over not changing their policy in this case.

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Basically, this is the report of the facts and opinions regarding the show and conference. However, there are a few more things which must be said.

First, we want to correct a mistaken impression that seemed to gather momentum during the exposition week. MATERIALS & METHODS had no official connection with the show. The idea was that of Clapp & Poliak, Inc., an astute show management firm which realized that a need existed for a materials show. We agreed with this belief and backed the idea with every facility at our command, with the result that we received plaudits that should have gone to Clapp & Poliak. Perhaps another reason is that our editor served as chairman of the Basic Materials Conference and this led many people to assume that it was our show.

Second, on behalf of the exhibitors, those attending the exposition and conference, registrants, and ourselves, we want to thank Clapp & Poliak, Inc. for having the vision and the courage to undertake a Materials Show and Conference. They put into three dimensions the information we present on the pages of a magazine. We are happy to have been able to contribute in our small way to the success of the venture.

William P. Winsor, Publisher
T. C. Du Mond, Editor

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Russian Steels Today

Here for the first time since the "iron curtain" descended is a detailed picture of the steels currently being used in Russia . . . Tells how the Russians classify their steels by application . . . Gives compositions and applications of the commonly used grades.

by CARL A. ZAPFFE, Metallurgist

• TODAY IT IS a matter of considerable interest to engineers outside Russia to learn just what progress is being made there in the production and use of engineering materials. In the case of metals and alloys, and steels in particular, an accurate appraisal can be obtained from a study of some forty post-war Russian books. This article presents a description of the standard steels current in 1950/51 in Russia. The information is based principally on five books given in the appended bibliography.

Coding and Identification

Similar to our SAE, AISI, or ASTM "type numbers", Russian steels are given a "Mark" designation. This is usually a combination of numbers and letters, though sometimes a name is retained, such as chromium - nickel - manganese, rail steel, ferrosilid, and so forth.

A number at extreme left represents the average carbon content in points. Subsequent letters designate alloy additions: a number following an alloy symbol approximates its weight percent in units for contents greater than 1.5%. An "A" terminating the code signifies high-quality, shortly to be described. Thus, the Russian Mark 12Kb2N4A defines an alloy of high-quality grade containing approximately 0.12 carbon, 2 chromium, and 4% nickel.

All designations in the tables that follow are translated and/or transliterated. They therefore often show but little resemblance to the original Russian code.

Four major classes cover all Russian steels distinguished on a basis of general application. They are:

Class I—Structural
Class II—Machine
  (A) General purpose
  (B) Special purpose
Class III—Instrumental
Class IV—Special

The first class comprises the ordinary engineering grades, commonly used in the as-rolled condition; the second, the carbon and alloy steels for machine construction, usually heat-treated; the third, special carbon and alloy grades of high quality; and the fourth, alloys of special electrical, magnetic, chemical, and physical properties. These four classes are further subdivided among 22 groups, and these in turn occasionally in subgroups.

Since the Russian and English alphabets have only the first two letters in common, subgroups in the tabulation beyond "b" are arbitrarily given progressive English letters without regard for the original Russian. It is believed that the resulting simplification outweighs any loss in exactness of description.

Another feature of Russian standardization is the consideration given steel quality, this in turn commonly being a function of the method of manufacture. Thus, specification GOST 380-50 divides the ordinary carbon steels ST 0, St 1, St 2, etc. between open-hearth products MSt 0, MSt 1, etc., and Bessemer products BSt 0, Bst 1, etc. The "M" derives from "Martin", the Continental name for the open-hearth furnace.

Three categories of quality are recognized: 1) ordinary, 2) quality, and 3) high-quality. The first comprises killed, semi-killed, and rimming steels, both open-hearth and Bessemer, usually with less than 0.60% carbon. Acid and basic processes are included for both open-hearth and converter, the basic Bessemer being called the Thomas converter in accordance with Continental usage. Sulfur and phosphorus run as high as 0.060 and 0.070%, respectively, in open-hearth steel ST 0, but 0.055 and 0.050% in remaining ST grades. Whereas the Bessemer analogs show sulfur and phosphorus up to 0.070 and 0.090%, respectively, in steel ST 0, and 0.065 and 0.085% in the remaining grades.

In the quality category, the basic open-hearth is commonly used, with observance of certain melting precautions. Both carbon and alloy steels are included. The sulfur and phosphorus limits vary with the Mark, but are commonly less than 0.040/0.045%. The quality accordingly derives principally from the lessened nonmetallics.

Finally, the high-quality category centers upon high-carbon and high-alloy grades made in the electric furnace or acid open-hearth, less commonly in the basic open-hearth. GOST tightens the specifications for these grades by narrowing the composition ranges and by placing sulfur and phosphorus maxima at 0.03% or even less. As an example, steel 20KhGS has a carbon range of 0.15-0.25%, whereas the range for 20KhGSA is 0.17-0.24%.

In the table, all standardized steels to be found in the several listed Russian texts are arranged in the order given by Pogodin-Alekseev: by class, group, and subgroup along with Mark, composition, and typical application. The text will supply certain further information; and attention will be called to occasional nonconformities among data of the several authors. Much of this is due to rapidly changing specifications in Russian technology, although some is attributable to misprint and other errors.

Class I

Group	Mark	Analysis, %						Applications
		C	Mn	Si	Cr	Ni	Others	
1	St. 0	>.23	Not Specified					General building construction
	St. 1	.07-.12	.35-.50	—	—	—	—	Rivets, anchor bolts
	St. 2	.09-.15	.35-.50	—	—	—	—	Rivets, strip, tubing
	St. 3	.14-.22	.40-.65	.12-.30	—	—	—	Locomotive and bridge construction
	St. 3 (rimming)	.14-.22	.40-.65	trace	—	—	—	Structural sheet, plate, bar
2	N1-1	>.15	.5-.8	.3-.5	.5-.8	.3-.7	Cu, .3-.5	Scaffolding
	N1-2	.12-.18	.5-.8	.3-.5	.5-.8	.3-.7	Cu, .3-.5	Scaffolding
	Manganese	.20-.25	.90-1.20	.20-.40	—	—	—	Shipbuilding
	Copper	.15-.25	.30-.65	.20-.40	—	—	Cu, .15-.25	Shipbuilding
	Chromium-Manganese-Silicon	.20-.25	.90-1.20	.60-.90	.30-.60	—	—	Shipbuilding

Structural Steels—Class I

Group 1—These are the plain carbon steels of low and medium range, commonly used in the as-rolled condition. They are purchased by Mark number, the chemistry being more or less a function of the melting process. Mechanical properties fall within a range indicated in the accompanying table. If purchased as an "A" or quality grade, the manufacturer guarantees the designated mechanical properties.

Only four typical steels: St 0, -1, -2, -3 are shown, with one rimming grade added; but certain of these steels are variously made as killed, semi-killed, and rimmed, also as open-hearth or Bessemer. The principal distinction in analysis for the rimming grades, of course, is the "trace" silicon content, and for Bessemer grades generally reduced carbon, silicon and manganese. None of these variations is included in the table since the practice is more or less common to our own.

Rimming grades, the Russian authors explain, are preferred for cold-forming operations, but their greater gas content leads to aging and blue brittleness, making them inapplicable for service in the 150-200C

Group 2—These are miscellaneous low-alloy structural steels, much less used than those in Group 1. The tabulation is probably typical rather than complete, so far as representing all Russian steels of this sort. It will be noticed that only two of the five have been coded.

Mechanical Properties

	Tensile Strength, psi	Yield Strength psi	%, Elong	Bhn
St 0	45/65,000	>27,000	>22	>132
St 1	45/57,000	—	>33	>132
St 2	48/60,000	>31,000	>31	>132
St 3	54/67,000	>34,000	>27	>132
St 3 (rimming)	54/67,000	>34,000	>27	>132

Machine Steels—Class II

By composition, these steels are carbon or alloy; by manufacture, quality and high-quality. They are usually heat-treated. Distinctions are not always clear between Classes I and II, e.g., St3 in Class I, when used for bridge construction, has some special marks of quality in that sulfur and phosphorus are reduced to 0.05 and 0.045%, respectively. This steel repeats its listing (Class II, Group 3a) because of its usefulness in less critical machine parts, such as the chassis of trucks and carts. One will note occasional duplication throughout the table for similar reasons, since the tabulation is based primarily upon application.

Two major subdivisions are recognized for Class II: (A) general purpose steels and (B) special purpose steels. The first comprises Groups 3, 4, 5 and 6 separated on a basis of hardenability. Specifications for this last group also require high tensile and impact strengths after heat treatment. Applications are axles, gears, and various parts in automobile, aircraft, and machine construction. Some of the cheaper grades appear in Group 3, such as St 4, –5, –6 and even a repetition of St 2 and St 3, since these can be used for lightly loaded and less critical parts such as bolts, cotter pins, and the shafts and axles of low-power motors.

Subclass IIB, comprises Groups 7-12 for machine steels requiring special mechanical strength and/or resistance to chemical attack.

Class IIA—General Purpose

Group 3—Several subdivisions distinguish (a) quality carbon steel, (b) ordinary carbon steel, and (c) manganese modifications. Thus, Subgroup 3a begins with three rimming steels, then completes the listing of the plain steels up to 0.60% carbon. Maxima for sulfur and phosphorus have been added from information in several books, since the Pogodin-Alekseev text seldom gives them. One will notice overlaps in the analyses of steels 15/20, 30/35, 45/50 and 50/55.

In Subgroup 3b, certain carbon steels, as remarked earlier, now have a "quality" guarantee by the manufacturer.

In subgroup 3c, the "G" following the Mark number of the corresponding carbon steel indicates an increased manganese content. Principal features, according to the Russian authors, are a better weldability, greater uniformity in carburized sections, and a somewhat higher strength and hardness.

Group 4—These are the medium-hardenability steels, divided among four subgroups: (a) manganese steel, (b) chromium steel, (c) chromium-silicon steel, and (d) chromium-vanadium steel. The first is a continuation of Subgroup 3c with manganese further increased to 1.50%. The chromium steels comprise both carburizing and noncarburizing grades; and special quality "A" grades are inserted to illustrate refinements in carbon, sulfur, and phosphorus contents.

Subgroups 4c and 4d are self-explanatory, the latter being used for lesser thicknesses because of a lesser hardenability. Slavin shows nickel 0.3% and manganese 0.5 to 0.8% for steel 40KhFA, quoting GOST 4543-48, which may be an earlier specification than that used by Pogodin.

Group 5—Increased hardenability steels, for section thicknesses of 2-3 in., are subdivided among (a) chromium-nickel, (b) chromium-nickel-molybdenum, (c) chromium-manganese-titanium, (d) chrominum-manganse-silicon, (e) chromium- molybdenum, (f) chromium-molybdenum-vanadium and (g) chromium-molybdenum-aluminum. Such steels as Subgroup 5c are principally designed as substitutes for nickel grades. Again Slavin provides a non-conformity for several of the analyses in showing chromium 0.8-1.1% instead of the 0.90-1.20% in 30KhGS, and the 0.80-1.40% in 20KhMA and 30KhMA.

Group 6 — High-hardenability steels, designed for sections exceed-

General Purpose Steels of Varied Hardenability

		For Section Sizes:
Group 3	Low hardenability	½ in.
Group 4	Medium hardenability	1-1½ in.
Group 5	Increased hardenability	2-3 in.
Group 6	High hardenability	3 in.

Class IIA

Group	Mark	Analysis, %						Applications
		C	Mn	Si	Cr	Ni	Others	
3a	08KP	.05-.12	.25-.50	<.03	<.25	<.30	Rimming	Thin strip and deep-drawn parts
	10KP	.05-.15	.25-.50	<.03	<.25	<.30	Rimming	Thin strip and deep-drawn parts
	15KP	.10-.20	.25-.50	<.03	<.30	<.30	Rimming	Same, but higher strength
	08	.05-.12	.25-.50	.15-.30	<.25	<.30	S, .04; P, .04	Welding applications
	10	.05-.15	.35-.65	.15-.30	<.25	<.30		Welding, case-hardening
	15	.10-.20	.35-.60	.15-.30	<.30	<.30		Same, higher strength
	20	.15-.25	.35-.60	.15-.30	<.30	<.30		Shafts, beams
	25	.20-.25	.45-.70	.15-.30	<.30	<.30		Axles, couplings
	30	.25-.35	.45-.70	.15-.30	<.30	<.30	S, .045	Connecting rods, rotors, shafts
	35	.30-.40	.45-.70	.15-.30	<.30	<.30	P, .045	Connecting rods, rotors, shafts
	40	.35-.45	.45-.70	.15-.30	<.30	<.30		Gears, pinions, piston rods
	45	.40-.50	.45-.70	.15-.30	<.30	<.30		Spindles, mandrels, toothed gears
	50	.45-.55	.45-.70	.15-.30	<.30	<.30		Spindles, mandrels, toothed gears
	55	.50-.60	.45-.70	.15-.30	<.30	<.30		Plate-mill rolls
3b	St. 3	.14-.22	.40-.65	.12-.30	—	—	S, <.55; P, <.50 (Open Hearth)	Frames, booms, rabbles, hoops
	St. 4	.18-.27	.40-.70	.12-.30	—	—		Bolts, tie-rods, connectors
	St. 5	.28-.37	.50-.80	.17-.40	—	—	S, <.065; P, <.85 (Bessemer)	Wagon springs. hammer heads
	St. 6	.38-.50	.50-.80	.17-.40	—	—		Axes, hammer faces spindles gears
	St. 7	.50-.63	.56-.85	.17-.40	—	—		Axes, hammer faces spindles gears
3c	15 G	.10-.20	.70-1.00	.17-.37	<.30	<.30	S, <.045	Welding and carburizing applications
	20 G	.15-.25	.70-1.00	.17-.37	<.30	<.30	P, <.045	Welding and carburizing applications
	30 G	.25-.35	.70-1.00	.17-.37	<.30	<.30	S, <.045	Guy wire, cranks and jacks for automobiles and tractors
	40 G	.35-.45	.70-1.00	.17-.37	<.30	<.30	P, <.040	Rolls, spindles, axles
	50 G	.45-.55	.70-1.00	.17-.37	<.30	<.30	S, <.045; P <.045	As normalized, for wear-resistant discs, pinions, pump parts
4a	10 G2	.05-.15	1.20-1.60	.17-.37	<.30	<.30		Welded and forged articles, excellent weldability
	12 G2	.08-.17	1.20-1.60	.17-.37	<.30	<.30		Welded and forged articles, excellent weldability
	30 G2	.25-.35	1.40-1.80	.17-.37	<.30	<.30	S, <.045	Trucks axles, trunnions, pins and pivots
	35 G2	.30-.40	1.40-1.80	.17-.37	<.30	<.30	P, <.045	Crankshafts, semi-axles, pins
	40 G2	.35-.45	1.40-1.80	.17-.37	<.30	<.30		Universal joints, rockers, train axles
	45 G2	.40-.50	1.40-1.80	.17-.37	<.30	<.30		Universal joints, rockers, train axles
	50 G2	.45-.55	1.40-1.80	.17-.37	<.30	<.30	P. <.04	Universal joints, rockers, train axles

(Continued on page 82)

Class IIA—Continued

Group	Mark	Analysis, % C	Mn	Si	Cr	Ni	Others	Applications
4b	15 Kh	.12-.20	.30-.60	.17-.37	.70-1.00	<.40	S, P, <.04 in Kh grades S, <.03; P, <.035 in KhA grades	Carburized and hardened in oil. Deeper hardening than 15, 20
	15 KhA	.12-.18	.40-.70	.17-.37	.70-1.00	<.40		Gears, piston pins
	20 Kh	.15-.25	.50-.80	.17-.37	.70-1.00	<.40		Gears, piston pins
	20 KhA	.18-.24	.30-.60	.17-.37	.70-1.00	<.40		Gears, piston pins
	30 Kh	.25-.35	.50-.80	.17-.37	.80-1.10	<.40		Axles rolls, gears
	30 KhA	.25-.33	.50-.80	.17-.37	.80-1.10	<.40		Axles, rolls, gears
	35 Kh	.30-.40	.50-.80	.17-.37	.80-1.10	<.40		Axles, rolls, gears
	40 Kh	.35-.45	.50-.80	.17-.37	.80-1.10	<.40		Noncarburized crankshaft pins
	45 Kh	.40-.50	.50-.80	.17-.37	.80-1.10	<.40		Parts subject to high stress and wear
	45 KhA	.42-.50	.50-.80	.17-.37	.80-1.10	<.40		Parts subject to high stress and wear
	50 Kh	.45-.55	.50-.80	.17-.37	.80-1.10	<.40		Parts subject to high stress and wear
	50 KhA	.47-.55	.50-.80	.17-.37	.80-1.10	<.40		Parts subject to high stress and wear
4c	33 KhS	.27-.37	.30-.60	1.0-1.3	1.30-1.60	<.40		Thinwalled tubing axles, shafts
	33 KhSA	.29-.37	.30-.60	1.0-1.3	1.30-1.60	<.40		Tempered 250/270 C, 210,000 psi min tens
	40 KhS	.35-.45	.30-.60	1.2-1.6	1.30-1.60	<.40		Noncarburized parts such as gears
	40 KhSA	.37-.45	.30-.60	1.2-1.6	1.30-1.60	<.40		Tempered 250/270 C, 240,000 psi min tens
4d	15 KhF	.12-.20	.30-.60	.17-.37	.80-1.10	<.40	V, <.10-.20	Cam shafts, gears, piston pins
	20 KhF	.15-.25	.40-.70	.17-.37	.80-1.10	<.30		Cam shafts, gears, piston pins
	15 KhFA	.12-.18	.30-.60	.17-.37	.80-1.10	<.40		Cam shafts, gears, piston pins
	40 KhFA	.37-.45	.30-.60	.17-.37	.80-1.10	<.40		Crankshafts, crossheads, nitrided parts
5a	12 KhN2A	.11-.17	.30-.60	.17-.37	.60-.90	1.50-2.00		Carburized parts per high wear resistance
	20 KhN	.15-.25	.40-.70	.17-.37	.45-.75	1.00-1.50		Carburized parts per high wear resistance
	40 KhN	.35-.45	.50-.80	.17-.37	.45-.75	1.00-1.50		Special bolts and connectors
	40 KhNA	.37-.45	.50-.80	.17-.37	.45-.75	1.00-1.50		Special bolts and connectors
5b	40 KhNMA	.37-.45	.50-.80	.17-.37	.6-.9	1.25-1.75	Mo, .15-.25	Highly stressed parts
5c	18 KhGT	.16-.24	.80-1.10	.17-.37	1.0-1.3	<.40	Ti, .08-.15	Carburized parts substitute for 20 KhN, 12 KhN2A, etc.
5d	20 KhGS	.15-.25	.80-1.10	.90-1.20	.80-1.10	<.40		Sheet and Strip
	20 KhGSA	.17-.24	.80-1.10	.90-1.20	.80-1.10	<.40		Welding and stamping operations
	25 KhGS	.22-.30	.80-1.10	.90-1.20	.80-1.10	<.40		Joins special frames, tubing
	25 KhGSA	.22-.29	.80-1.10	.90-1.20	.80-1.10	<.40		Substitute for Cr-Mo grade
	30 KhGS	.25-.35	.80-1.10	.90-1.20	.90-1.20	—.40		As above, with higher tensile, less impact strength
	30 KhGSA	.28-.35	.80-1.10	.90-1.20	.90-1.20	—.40		Gears and axles
	35 KhGS	.30-.40	.80-1.10	1.10-1.40	1.10-1.40	—.40		Substitutes for Ni and Mo grades
	35 KhGSA	.32-.39	.80-1.10	1.10-1.40	1.10-1.40	—.40		Substitutes for Ni and Mo grades
5e	20 KhMA	.17-.24	.40-.70	.17-.37	.80-1.40	—.40	Mo, .15-.25	Welding electrodes, welded articles
	30 KhMA	.25-.33	.40-.70	.17-.37	.80-1.40	—.40		Special tubing, welded parts, shafts
	35 KhMA	.32-.40	.40-.70	.17-.37	.80-1.10	—.40		Automotive cylinders, inlet valves, disc bushings
	35 Kh2MA	.32-.40	.40-.70	.17-.37	1.6-1.9	<.40		Cylinders in heavy-service meters
5f	35 KhMFA	.30-.38	.40-.70	.17-.37	1.0-1.3	<.40	Mo, .2-.3 V, .1-.2	Crankshafts, parts in saving equipment and steam turbines
5g	38 KhMYuA	.35-.42	.3-.6	.17-.37	1.35-1.65	<.40	Mo, .3-.5 Al, .7-1.1	Nitriding, for highly stressed parts
6a	12 Kh2N3MA	.10-.17	.30-.60	.17-.37	1.45-1.75	2.75-3.25	Mo, .2-.3	Heavy carburized parts of complex section
	18 Kh2N4MA	.15-.22	.40-.70	.17-.37	1.45-1.75	3.25-3.75		Crankshafts, heavy carbonized parts
	18 KhNVA	.21-.28	.25-.55	.17-.37	1.35-1.65	4.0-4.5	W, .8-1.2	Same, but higher strength requirements
	25 KhNVA	.21-.28	.25-.55	.17-.37	1.35-1.65	4.0-4.5		Same, but higher strength requirements
6b	12 Kh2NAA	.11-.17	.30-.60	.17-.37	1.25-1.75	3.25-3.75	S, <.03 P, <.035	Highly stressed carburized gears and axles
	12 KhN3A	.11-.17	.30-.60	.17-.37	.60-.90	2.75-3.25		Highly stressed carburized gears and axles
	20 KhN3A	.17-.25	.30-.60	.17-.37	.60-.90	2.75-3.25		Carburized parts with higher core strength
	30 KhN3A	.27-.35	.30-.60	.17-.37	.60-.90	2.75-3.25		Heavy forgings for high-strength shafts, connectors
	37 KhN3A	.33-.41	.30-.60	.17-.37	1.20-1.60	3.0-3.5		Heavy forgings for high-strength shafts, connectors

ing 3 in., are subdivided between (a) chromium-molybdenum/tungsten and (b) chromium-nickel alloys. Pogodin gives carbon 0.21-0.78% for steel 25KhNVA, which is obviously a misprint for 0.21-0.28% and is so shown in the table. These are all high-quality steels with sulfur, phosphorus 0.03 and 0.035%, respectively, and the carbon range restricted as usual.

Class IIB—Special Purpose

Group 7—The first of the special purpose steels are the railway engineering compositions. A separate review has been prepared on Russian rail practice because of an informative text recently appearing in this field. It will only be remarked here that the carbon content of rail steel is generally kept lower in Russia than in America; and some of their ideas on flake formation are novel.

Group 8—Because spring steels are rated on the basis of special mechanical properties, a tabulation of chemical composition does little to define the technology. Several distinctions mentioned in the text include VS for high resistance, OVS for extra-high resistance, and R for piano grade.

Group 9—Something of an enigma is presented by Russian technology for free-machining steel. In the present carbon and low-alloy classification, sulfur and phosphorus values are as tabulated under Group 9. Selenium and tellurium are occasionally mentioned as free-machining additions, but usually any further description is lacking. Among minor irregularities which are suggestively numerous: Slavin gives a phosphorus maximum of 0.08% for steels A 30 and A 35 instead of the 0.06% shown in the table, and Pogodin gives sulfur 0.03 to 0.20%

for steel A 12, whereas Slavin gives 0.08 to 0.20%. This latter, of course, could be a misprint, but it is characteristic of frequent examples of indecisive discussion that might be cited. An outstanding feature of Russian steel technology in general, and their stainless steel technology in particular, is the underdevelopment of free-machining compositions.

Group 10—Wear-resistant steels are given two subgroupings to separate the Hadfield manganese and the chromium-carbide types from others. Steel EI 161 is a composition escaping recognition by this reviewer among American analyses, whereas EI 229 is the AISI Type 440-C stainless steel.

Group 11—Steels for service at elevated temperature are subdivided among (a) steels resistant to aging and blue-brittleness, for service in the range 200-300C, (b) creep-resistant steels for 400-500C, and (c) creep- and heat-resistant steels for temperatures up to 700C. The "K" designates boiler steel, being the initial of the Russian "Kotel" for boiler. This subgroup utilizes rimming steel, also a few low-alloy steels containing molybdenum. Graphitization of steels in this type of service, incidentally, has received discussion in Russia. Subgroup 11b contains customary low-alloy steels. Subgroup 11c is further divided between ferritic types of medium-alloy and stainless steels for the range 500-600C, and austenitic stainless steels for 600-700C.

Group 12 — Corrosion-resistant steels are separated into five subgroups of special service: (a) atmospheric corrosion at ordinary temperatures, (b) atmospheric corrosion at elevated temperatures, (c) corrosion in mild liquids, (d) corrosion in active liquids, and (e) corrosion in very active liquids. Only a copper steel is listed for the first category. The second is still further subdivided between ferritic and austenitic steels, all of the latter and two of the former being of stainless composition. A 66 MF listing by Pogodin is believed to be a misprint for Kh6MF, and is so listed in the table. The last five grades in Group 12b2 are inserted from the texts of Slavin and Klinov.

Standard martensitic and ferritic stainless steels appear in Group 12c. Parenthetical codes occasionally inserted throughout this table are apparently identifications by which the alloys have previously been known.

In Subgroup 12d the stainless steels are for the most part austenitic, though some unusual analyses appear. The four grades following Ya2 are inserts from Slavin and Klinov, as are the four molybdenum-containing grades following Ya1M. The chromium-manganese-nickel austenitic steels are interesting because of current American developments. Pogodin's tabulation is incomplete so far as Russian stainless steels are concerned, but additions from the other texts provide a fairly comprehensive coverage. Russian technology in the stainless field is scarcely impressive, lacking both scope and consistency, although it is making rapid strides, and occasionally may be ahead of American technology.

Slavin defines the titanium-stabilized grades on the basis of titanium = 5 × (carbon –0.05) %, whereas Klinov defines titanium = 5× (carbon –0.03) %. American metallurgy neither accepts as harmless a carbon content of 0.03%, nor does it remotely suggest a reason for a boundary at 0.05%. A YaO grade has also been inserted in this table from Slavin's book. It is the Russian ELC modification of 18-8, but is stated to contain about 0.04% carbon, which is unacceptably high for American practice. However, the titanium addition is an interesting innovation of corrective sort probably to be interpreted as a circumvention of those difficulties in producing ELC stainless which are now easily surmounted in America through development of furnace practice.

Subgroup 12e comprises two silicon ferritic stainless steels, one containing molybdenum; also some exceptionally high chromium-carbon compositions. These latter are recommended for resistance to concentrated H_2SO_4.

Resolution of the inconsistencies among descriptions of stainless steels by the various Russian authors is often quite difficult, repeatedly suggesting that their technology in this field is considerably less clearly formulated than in America. Some of these differences are insignificant, others are not. In any event, the lack of agreement necessarily reflects upon the precision of their technology.

Class IIB

Group	Mark	Analysis, %						Applications
		C	Mn	Si	Cr	Ni	Others	
7	Axle Steel	.30-.45	.50-.90	.15-.35	—	—	—	Axles of coaches and tender
	Axle Steel	.35-.45	.50-.80	.15-.35	<.30	<.50	—	Locomotive axles
	45 G2	.40-.50	1.40-1.80	.17-.37	<.30	<.30	—	Axles of steam locomotives, coaches, trolleys
	Tire I	.50-.65	.60-.90	.15-.35	—	—	—	Tires on passenger locomotives
	Tire II	.55-.70	.60-.90	.15-.35	—	—	—	Tires on coaches
	Tire III	.60-.75	.60-.90	.15-.35	—	—	—	Tires on tenders
	Tire IV	.65-.80	.50-.80	.15-.35	—	—	—	Drive wheels on freight locomotives
	Rail:							
	Open Hearth	.53-.70	.60-.90	.15-.30	—	—	—	Rails
8	55	.50-.60	.50-.80	.17-.37	<.30	<.30	—	Rolling stock springs, railway transportation
	60	.55-.60	.50-.80	.17-.37	<.30	<.30	—	Rolling stock springs, railway transportation
	65	.60-.70	.50-.80	.17-.37	<.30	<.30	—	Same, also valve springs
	60 G	.55-.65	.70-1.00	.17-.37	<.30	<.30	—	Same, but springs of larger transverse section
	65 G	.60-.70	.70-1.60	.17-.37	<.30	<.30	—	Same, but springs of larger transverse section
	55 S2	.50-.60	.60-.90	1.50-2.00	<.30	<.30	—	Automotive springs
	50 KhGA	.43-.50	.70-1.00	.17-.37	<.30	<.30	—	Automotive springs
	60 S2A	.55-.65	.70-1.00	1.50-2.00	<.30	<.30	—	Coil springs
	50 KhFA	.46-.54	.50-.80	.17-.37	.80-1.10	<.30	V, .10-.20	Special springs, as for heavy automobiles
	U7-U12	(See Groups 13, 14)						Cold-drawn springs and mechanisms for instruments, clocks
	U7A-U12A	(See Groups 13, 14)						Cold-drawn springs and mechanisms for instruments, clocks
							S P	
9	A 12	.08-.16	.6-.9	.15-.35	—	—	.08-.20 .08-.15	Screws, bolts, nuts
	A 15	.10-.20	.7-.10	.15-.35	—	—	.08-.15 <.06	Intricate parts of sewing, textile and printing machinery
	A 156	.10-.20	1.0-1.4	.15-.35	—	—	.08-.15 <.06	Special parts with higher strength, less impact resistance
	A 20	.15-.25	.6-.9	.15-.35	—	—	.08-.15 <.06	
	A 30	.25-.35	.7-1.0	.15-.35	—	—	.08-.15 <.06	
	A 35	.30-.40	.8-1.2	.15-.35	—	—	.08-.15 <.06	

(Continued on page 84)

Class IIB—Continued

Group	Mark	C	Mn	Si	Cr	Ni	Others	Applications
10a	ShKh6	.95–1.1	.2–.4	.15–.35	.45–.75	<.30	—	Roller, ball, pin bearings <.4 in.
	ShKh9	.95–1.1	.2–.4	.15–.35	.75–1.05	<.30	—	Same <.7 in.
	ShKh15	.95–1.1	.2–.4	.15–.35	1.3–1.65	<.30	—	Same <.7 in.
	12 KhN3	<.17	.3–.6	.15–.35	.8–1.1	2.8–3.3	—	Large carburized bearings
	EI 161	.5–.6	.3–.6	.15–.35	6.5–7.5	6.5–7.5	W, .2–.4; V, —.3	Bearings for elevated temperature
	EI 229	.9–1.0	.3–.6	.15–.35	17.0–18.5	<.30	—	Bearings requiring rust-resistance
10b	G13	.9–1.4	11–14	.20–.60	—.20	—.20	—	Heavy earth-moving equipment, impact conditions
	Kh34	1.5–2.2	.3–.6	1.30–1.70	30–32.0	—.20	—	Wear- and rust-resistant bearings, no impact
11a	3G	.12–.22	—	.08–.20	—	—	—	Plate for boiler furnaces
	3K	.12–.22	—	—	—	—	—	Boilers for locomotives and ships
	15M	.10–.18	.40–.70	.17–.37	<.30	<.30	Mo, .40–.55	Boilers in higher pressure range
	20M	.15–.25	.40–.70	.17–.37	<.30	<.30	Mo, .40–.55	Boilers in higher pressure range
	15KhMA	.10–.18	.40–.70	.17–.37	.8–1.1	<.30	Mo, .40–.55	Boilers in higher pressure range
11b	15M	.10–.18	.40–.70	.17–.37	<.30	<.30	Mo, .40–.55	Equipment for superheated steam up to 400 C
	12KhM	—.16	.40–.70	.17–.37	.8–1.1	<.30	Mo, .40–.55	Same, up to 450 C
	30M	.25–.35	.50–.80	.17–.37	<.30	<.40	Mo, .40–.55	Turbine parts for 425 to 450 C
	30M	.25–.35	.50–.80	.17–.37	<.30	<.40	Mo, .40–.55	Same for 450 to 500 C
	35KhM	.30–.40	.40–.70	.17–.37	.8–1.1	<.40	Mo, .15–.25	Turbine parts of heavier section: rotors, rods, axles
	40KhNMA	.36–.44	.50–.80	.17–.37	.6–.9	1.25–1.75	Mo, .15–.25	Same, for sections >4–6 in.
	33KhN MA	.29–.37	.50–.80	.17–.37	.8–1.1	2.50–3.00	Mo, .20–.30	Highly stressed turbine shafts, discs, rotors at 425 to 450 C
$11c_1$	Kh6	.10–.20	—	.20–.40	5.5–6.5	<.30	—	Cracking and hydrogenation equipment at high steam pressures
	15Kh6MF (Kh6MF)	.10–.20	—	.20–.40	5.5–6.5	<.30	V, .20–.30 Mo. .50–.70	Same, for more severe conditions
	SKh3	.35–.45	.30–.70	3.0–3.8	2.5–3.0	<.30	—	Internal combustion valves for truck and tractor motors
	Zh2 (2Kh14)	.15–.3	<.50	.2–.4	12.5–14.5	<.60	—	Blades of steam turbines
	SKh10M	.35–.45	.30–.70	1.9–2.5	9.0–10.5	<.60	Mo, .70–.90	Automobile exhaust valves (heat-resistant to 850 to 900 C)
	SKh12M (EI 72)	.25–.37	<.65	2.0–3.0	11.5–14.0	6.5–7.5	Mo, .40–.60	Intake and exhaust valves for low- and medium-power motors (heat-resistant to 950 C)
$11c_2$	YaIT	.16	<.70	<1.2	16.0–20.0	8.0–11.0	Ti, <.80	Excellent manifolds and mufflers for power motors (heat-resistant to 1000 C)
	Ya3S	.30–.40	<.70	2.3–2.9	16.0–20.0	23.0–27.0	—	Gas turbine and furnace parts under stress up to 1100 C
	EI 69	.40–.50	<.70	.3–.8	13.0–15.0	13.0–15.0	Mo, .25–.40 W, 2.0–2.8	Gas turbine blades, exhaust valves of power motors up to 1000 C
	EI 240	.40–.50	<.70	2.75–3.25	.3–15	13–15	Mo, .30–.40 W, 2.0–2.8	Exhaust valve seats up to 1050 C
12a	Copper Steel	.10–.20	—	.5–.8	—	—	C, .2–.3	Resistance to atmospheric corrosion
$12b_1$	Kh6	.10–.20	—	.2–.4	5.5–6.5	<.30	—	Cracking and hydrogenation equipment 500 to 600 C
	Kh6MF (15Kh6MF)	.10–.20	—	.2–.4	5.5–6.5	<.30	Mo. .5–.7 V, .2–.3	Same, also ammonia synthesis
	SKh3	.35–.45	.30–.70	3.0–3.8	2.5–3.0	<.30	—	Internal combustion valves, up to 800 C
	SKh10M	.35–.45	.30–.70	1.9–2.6	9.0–10.5	<.30	Mo, .7–.9	Exhaust valves in automobiles, up to 850 to 900 C
	SKh12M (EI 72)	.25–.37	<.65	2.0–3.0	11.5–14.0	6.5–7.0	Mo, .4–.6	Intake valves in power motors, exhaust valves in smaller motors, up to 950 C
	Kh28	.50–1.00	—	.5–1.3	26–30	—	—	Cast furnace parts, up to 1000–1100 C
$12b_2$	YaIT (10Kh18N8T)	<.14	<.70	<1.2	16–20	8–11	Ti, <.80	Exhaust manifolds, mufflers, cracking equipment serving 650-725 C; heat resistant to 1000 C
	Ya1S	.20–.30	.20–.50	.5–1.0	24–26	12–14	—	Mufflers, tubing, furnace supports, up to 1000–1100 C
	Ya3S	.30–.40	<.70	2.3–2.9	16–20	23–27	—	
	EI 211	<.20	.7–1.2	2.0–2.3	18–22	13–15	—	
	EI 307	.20	.2–.7	1.2–2.0	24–27	18–21	—	Same, heat-resistant up to 1100 C
	EI 332	<.25	2.0	<1.0	24–27	19–22	—	
	EI 417	<.2	<1.5	<1.0	22–25	17–20	—	
12c	Zh1 (IKh14)	<.14	<.50	<.70	12.5–14.0	<.30	S, <.035 P, <.035	Turbine blades, general service in water and steam
	Zh2 (2KhIA)	.15–1.23	<.50	<.70	12.5–14.0	<.30	S, <.035 P, <.035	
	Zh3 (3Kh14)	.24–.35	<.70	<.70	12.5–14.0	<.30	S, <.03 P, <.03	Same, but higher strength and hardness, less corrosion resistance
	Zh4 (4Kh14)	.35–.45	<.70	<.70	12.5–14.0	<.30	S, <.03 P, <.03	Surgical instruments, knives
	Zh17 (1Kh17)	<.12	<.70	<.70	16–18	<.30	—	Equipment exposed to oxidizing liquids, flue gases, but not requiring high strength or impact resistance
	Zh27	<.20	<1.5	<1.2	23–27	<.60	—	
12d	YaO	<.07	<.7	<.9	17–19	8.0–9.5	Ti, <.5	Pontoons and sheathing of hydroplanes; containers for manufacture of nitric acid lacquer, paint; equipment for salt water, oxidizing liquids weak alkalies
	Ya1 (10Kh18N8)	<.14	.20–.70	.30–.80	17–20	8.0–11.5	—	
	Ya1T (10Kh18N8T)	<.14	<.70	<1.2	17–20	8.0–11	Ti, <.80	As Ya1, but not heat treated after welding
	Ya2	.15–.26	.70	<.9	17–19	8.0–9.5	—	As Ya1, but higher strength
	EI 100	.15–.30	8–10	<.8	12–14	3.7–5.0	S <.03; P, <.06	
	EI 310	.35–.45	4–6	1.0–1.6	17–20	3.0–7.0	W, .8–1.0	
	EI 312	35–.45	3–5	1.4–2.2	17–20	5.0–7.0	—	
	EI 388	.38–.47	6–8	.9–1.4	14–16	5.0–7.0	Mo, .4–.8 V, 1.4–1.8 S. <.03; P, <.065	Special alloys principally substituting for Ya2
	YaIM	<.14	<.70	<.9	17–19	8.0–9.5	Mo, 3.0–4.5	
	EI 183	<.14	<2.0	<.8	17–19	8–11	Mo, 2.5–3.0	
	EI 400	.08	1.5	<1.0	16–19	10–14	Mo 2–3	
	EI 171	<.12	<1.5	<.9	16–18	11–14	Mo, 2.0–2.8 Ti, <.8 (5(% C–.05))	Service in sulfides and sulfites weak H_2SO_4, phosphoric acid salts
	EI 403	<.12	.9–1.5	.7–1.2	16–19	14–17	Mo 1.8–2.5 Nb, .8–1.2	
	EI 59	.17	.50–.80	<1.2	28–32	—	—	Hot phosphoric acid fuming HNC_3, conc. H_2SO_4; not for welding
12e	Ferrosilid	.50–.70	—	12–18	—	—	—	Cast pumps and conduit per sulfuric, nitric cold HCl
	Antikhlor	.50–.70	—	13–16	—	—	Mo, 3–4	Same, also boiling HCl
	Kh34	1.5–2.2	—	1.3–1.7	32–36	—	—	Cast rabbles for furnaces roasting copper concentrates. Suckers and cylinders of pumps transferring acid and alkaline solutions
	Kh28	1.7–2.5	—	1.3–0.7	28–32	—	—	Wear resistance increases with C content

Instrumental Steels—Class III

Instrumental steels are differentiated chemically as 1) alloy instrumental steel and 2) carbon instrumental steel, the latter again subdivided between quality and high-quality. This last contains lesser quantities of sulfur, phosphorus and manganese, hence has less nonmetallics, also less hardenability. By application, the steels are divided among (a) cutting instruments, (b) hot-forming instruments, (c) cold-forming instruments, (d) measuring instruments, and (e) special instruments, such as surgical.

Group 13—Cutting instruments are covered by this group, which are further subdivided among (a) high-speed steel, (b) alloy instrumental steel, and (c) carbon instrumental steel of quality and high-quality specifications. The tabulation is more or less self-explanatory. Common grades such as 18-4-1 are listed, along with others which might warrant some attention.

Group 14—These are steels for punches and dies, press forms, and heavy forging hammers.

Group 15—Most of these steels for cold-forming instruments, such as cold shears, finishing rolls, stamping and upsetting parts, are common to American practice.

Group 16—These comprise several grades of high-carbon, sometimes low-alloy, analysis used for simple instruments such as straight-edges, gauges, calipers.

Group 17—Here the analog of AISI Type 420 stainless steel is listed for surgical instruments, along with a high-carbon and low-chromium steel for razors and special cutting edges.

Class III

Group	Mark	Analysis, %						Applications
		C	Mn	Si	Cr	Ni	Others	
13a	RF1 (R18)	.7–.8	<.40	.4	3.8–4.8	—	W, 17.5–19 V, 1.0–1.4	High-speed tools for metals with BHN up to 300
	EI 262 (R9)	.85–.95	<.40	.4	4.0–4.6	—	W, 8.5–10.0 V, 2.0–2.6	Replaces RF1 for metals with BHN up to 250
13b	9KHS	.85–.95	.30–.60	1.20–1.60	.95–1.25	—	—	Drills, cutters, reamers for comparatively soft metals
	Kh(ShKh15)	.95–1.1	<.40	<.35	1.30–1.60	—	—	Reamers, dies, cutters, wood saws
	9KhVG	.85–.95	.80–1.10	.15–.35	.5–.8	—	W, .5–.8	Same when requiring minimum distortion from heat treatment
	KhV5	1.25–1.5	<.30	<.30	.4–.7	—	W, 4.5–5.5	Tools and cutters for finishing operations on tough materials
	65Kh	.6–.7	<.40	<.35	.5–.8	—	—	Woodworking tools
13c	U12A	1.1–1.25	.15–.25	<.30	<.2	<.25	—	Taps, reamers, files
	U10A	.95–1.09	.15–.25	<.30	<.2	<.25	—	Taps, reamers, files
	U8A	.75–.85	.25–.35	<.30	<.2	<.25	—	Axes and woodworking instruments
14	5KhNM	.50–.60	.50–.80	<.35	.5–.6	1.4–1.8	Mo .15–.30	Heavy forging hammers
	5KhGM	.50–.60	1.20–1.60	.25–.65	.6–.9	—	Mo, .15–.30	Medium forging hammers
	30KhGS	.25–.35	.8–1.10	.9–1.2	.8–1.1	—	—	Punches and dies
	3KhV8	.3–.4	.20–.40	<.35	2.2–2.7	—	W, 7.5–9.0 V, .2–.5	Press forms for casting copper alloys
	EI 160	.35–.45	<.40	<.35	7–9	—	W, 2.0–2.6 V, 2–5	Press forms for casting copper alloys
	4KhVS	.35–.44	.2–.40	.6–.9	1.0–1.3	—	W, 2.0–2.6	Press forms for casting aluminum alloys
	U7	.6–.74	<.40	<.35	<.20	<.25	—	Small stamps of simple form and requirement
15	Kh12	2.0–2.3	<.35	<.40	11.5–13.0	—	—	Complex and massive stamping machinery requiring wear-resistance and minimum deformation or annealing; wire drawing dies
	Kh12F	1.15–1.40	<.35	<.40	11.0–12.5	—	V, .16–.9	Same, but requiring higher impact resistance
	6KhS	.55–.65	<.40	.6–1.0	1.0–1.3	—	—	Cold shears
	Kh(ShKh15)	.95–1.10	<.40	<.35	1.3–1.6	—	—	Trimming and upsetting stamps
	U10	.95–1.09	<.30	<.35	~.2	—	—	Same, but finer gauge
	U8	.75–.85	<.40	<.35	~.2	—	—	Same, but finer gauge
	9Kh	.8–.95	.25–.35	.25–.45	.75–1.05	—	—	Rolls for cold-finishing
16	KhG	1.3–1.5	.45–.70	<.35	1.3–1.6	—	—	Gauges, calipers
	U12A	1.1–1.25	.15–.25	<.30	<.2	—	—	Instruments of simple form and requirement
	15	.10–.20	.35–.60	.15–.30	<.25	<.30	—	Straight-edged, flat templets, clamps; carburized parts
17	Zh4(4Kh14)	.35–.45	<.70	<.70	12–14	—	—	Surgical instruments
	Kh05	1.25–1.40	.20–.35	.20–.35	.4–.6	—	—	Razors

Special Steels—Class IV

Groups 18 to 22 contain those analyses having specialized applications. Compositions range from ingot iron to alloys which are scarcely 50% iron. Most are quality and high-quality, and they largely concern special melting practices such as vacuum, inert-atmosphere, and so forth.

Group 18—These are alloys having the special expansion coefficients required for carefully calibrated measuring devices or for glass-to-metal seals. Only Invar and Platinite are shown.

Group 19—Elinvar is the sole member of this group, chosen for such applications as watch springs because the modulus of elasticity is relatively independent of temperature.

Group 20—These are irons or alloys having special magnetic proper-

Class IV

Group	Mark	Analysis, %						Applications
		C	Mn	Si	Cr	Ni	Others	
18	EN36 (Invar)	<.26	<.70	<.35	—	35–37	—	Instruments requiring minimum coefficient of expansion
	EN42 (Platinite)	<.30	<.80	<.40	—	42–44	—	Calibrating instruments, coefficient of expansion equal to that of glass
19	Elinvar	<.70	1–2.0	—	~12	~36	W,4~.0	Watch springs
20a	Technical Iron	<.025	<.03	<.03	—	—	—	Magnetic circuits, deflectors
	E1 (Dynamo)	<.10	<.03	~1.0	—	—	—	Stators and rotors
	E2 (Dynamo)	<.10	<.03	~2.0	—	—	—	Stators and rotors
	E3 (Transformer)	<.10	<.30	~3.0	—	—	—	Transformers
	E4 (Transformer)	<.10	<.30	~4.0	—	—	—	Transformers
20b	EKh3	.90–1.10	<.40	—	2.8–3.8	—	—	Permanent magnets for instrument and machines
	EV5	.70–.80	<.40	—	.3–.5	—	W, 5–6.5	
	EK5	.90–1.00	<.40	—	5.5–6.5	—	Co, 5.5–6.5	
	EK15	.90–1.00	<.40	—	7.5–8.5	—	Co, 14–16 Mo, ~1.5	
							Al Co Cu	
20c	ALNI	<.10	—	—	—	~24	~13 — ~3.5	High-power permanent magnets
	Alnico	<.10	—	—	—	~17	~10 ~12.5 ~6.0	High-power permanent magnets
	Magnico	<.10	—	—	—	~14	~8 ~24.0 ~3.0	Specially powerful permanent magnets
21a	EN25	.3–.6	—	<.40	2.0–3.0	22–25	—	Slightly or paramagnetic instrument parts
	EN12KhG	.5–.6	4.0–5.5	<.60	3.0–4.5	11–13	—	
21b	EI503	.5–.6	7.5–9.5	.70	3.8–4.5	8–10	—	Nonmagnetic instrument parts
22	EN60 (Ferral)	<.25	.70–1.50	.5	12–15	—	Al, 3.5–5.5	Applications up to 1100 C
	KhN80 (Nichrome)	<.25	<1.5	<1.2	18–22	75–81	—	Same up to 1000 C
	EI318 (Alloy No. 1)	<.06	<.2	<.5	16–18	<.6	Al, 4.5–6.5	Same up to 1100 C
	EI340 (Alloy No. 2)	<.15	<.7	<1.2	23–27	<.6	Al, 4–7	Same up to 1200 C

ties. They are divided among three subgroups: (a) ingot iron and silicon transformer steel used in electrical and transformer circuits, (b) alloys of chromium, chromium-tungsten, chromium-cobalt, and chromium-cobalt-molybdenum used for permanent magnets, and (c) magnetic alloys of Alnico type.

Group 21—In contrast to the preceding Group, these are the paramagnetic and nonmagnetic alloys for special instrumentation.

Group 22—These are the iron-chromium-aluminum and chromium-nickel alloys used for electrical resistance and heating elements. The Russian investigator I. I. Kornilov has made an outstanding contribution in this field which should receive careful study.

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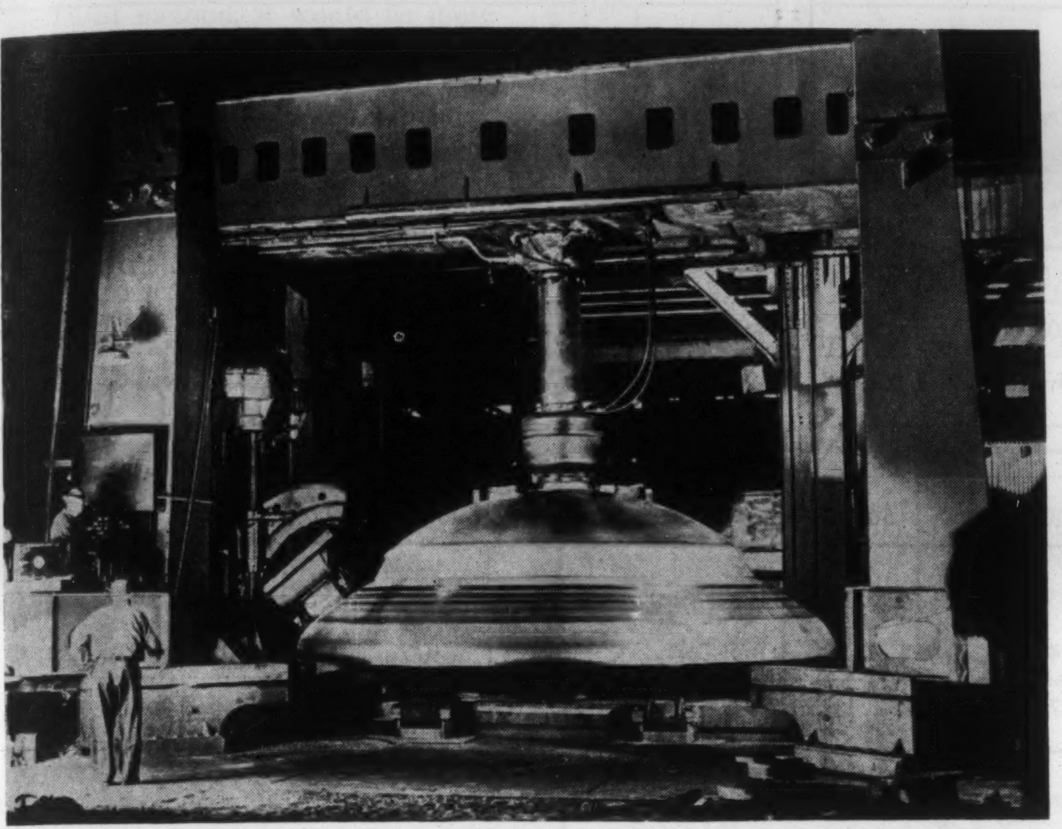
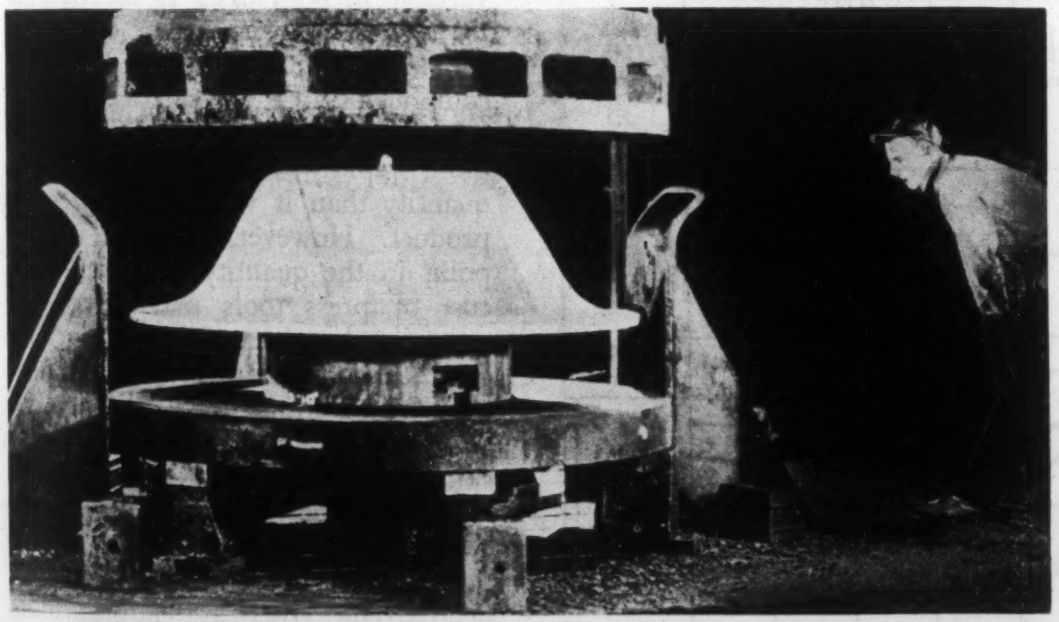
Which Metal Form ....



Steel tank heads are formed efficiently by spinning.

Spun ?



Shapes such as these are often best produced by drawing.

or Drawn ?

Both have advantages and limitations. The choice depends on the circumstances of the application. In some cases both methods are used.

by JOHN W. LENGBRIDGE, Project Engineer, Aluminum Goods, Ltd.

● SHAPING BY PRESSING is not limited to any one specific shape; it can be used for circular as well as noncircular products within the capacity of the presses used. Spinning, by contrast, is limited to products which are circular in cross sections at right angles to the axis of rotation, except for some minor work which can be done on ovals. Within its field, the scope of spinning is wide; in fact, it is limited only by the size of the equipment and the power available to make the metal flow. An evaluation of the two processes, therefore, must be confined to circular products which can be made on either type of equipment. It will be shown that spinning can be competitive as well as supplementary to press drawing and that each process is logical under certain sets of circumstances.

Before deciding on the use of either metal form the following factors should be considered:

1. Tool cost per unit by both methods. This will vary with lot sizes.
2. Labor and overhead cost per unit. This part of the unit cost is more or less constant regardless of quantity.
3. Delivery requirements.
4. Contour problems.
5. The possible use of both methods, each do a part of the work.
6. Dimensional accuracy requirements.

Costs

Hand spinning is predominently a *manual* operation and as such usually involves high labor costs. The nature of the operation, however, permits the use of simple and economical tooling. It can often be mechanized and, although this may increase tool and equipment costs, it brings unit labor costs closer to those of drawing.

Table 1—Unit Costs of . . .

Drawing vs Spinning

Drawing

Operation	Tool Cost	Prod./Hr.	Unit Labor Cost
1st Draw	$375.00	400	$0.0025
2nd Draw	400.00	400	.0025
Trim & Bead	100.00	300	.0035
Iron	125.00	200	.0050
Total	$1,000.00	Net Labor	$0.0135
		Overhead @ 200%	$0.0265
		Cost of Labor & Overhead	$0.040

Unit Cost

Lot Sizes	1000	2000	2300	3000	4000	5000
Labor Cost	$0.04	$0.04	$0.039	$0.039	$0.039	$0.035
Tool Cost	1.00	.50	.43	.34	.25	.20
Total Unit Cost	$1.04	$0.54	$0.47	$0.379	$0.277	$0.235

Spinning

Operation	Tool Cost	Prod./Hr.	Unit Labor Cost
1st Spin	$50.00	22	$0.065
2nd Spin Bead & Iron	100.00	18	.080
Total	$150.00	Net Labor	$0.140
		Overhead @ 200%	$0.280
		Cost of Labor & Overhead	$0.420

Unit Cost

Lot Sizes	1000	2000	2300	3000	4000	5000
Labor Cost	$0.42	$0.42	$0.405	$0.40	$0.40	$0.40
Tool Cost	.15	.075	.065	.050	.038	.03
Total Unit Cost	$0.57	$0.495	$0.470	$0.46	$0.443	$0.43

NOTE: These cost figures pertain to an aluminum utensil 6 in. dia. by 6 in. deep.

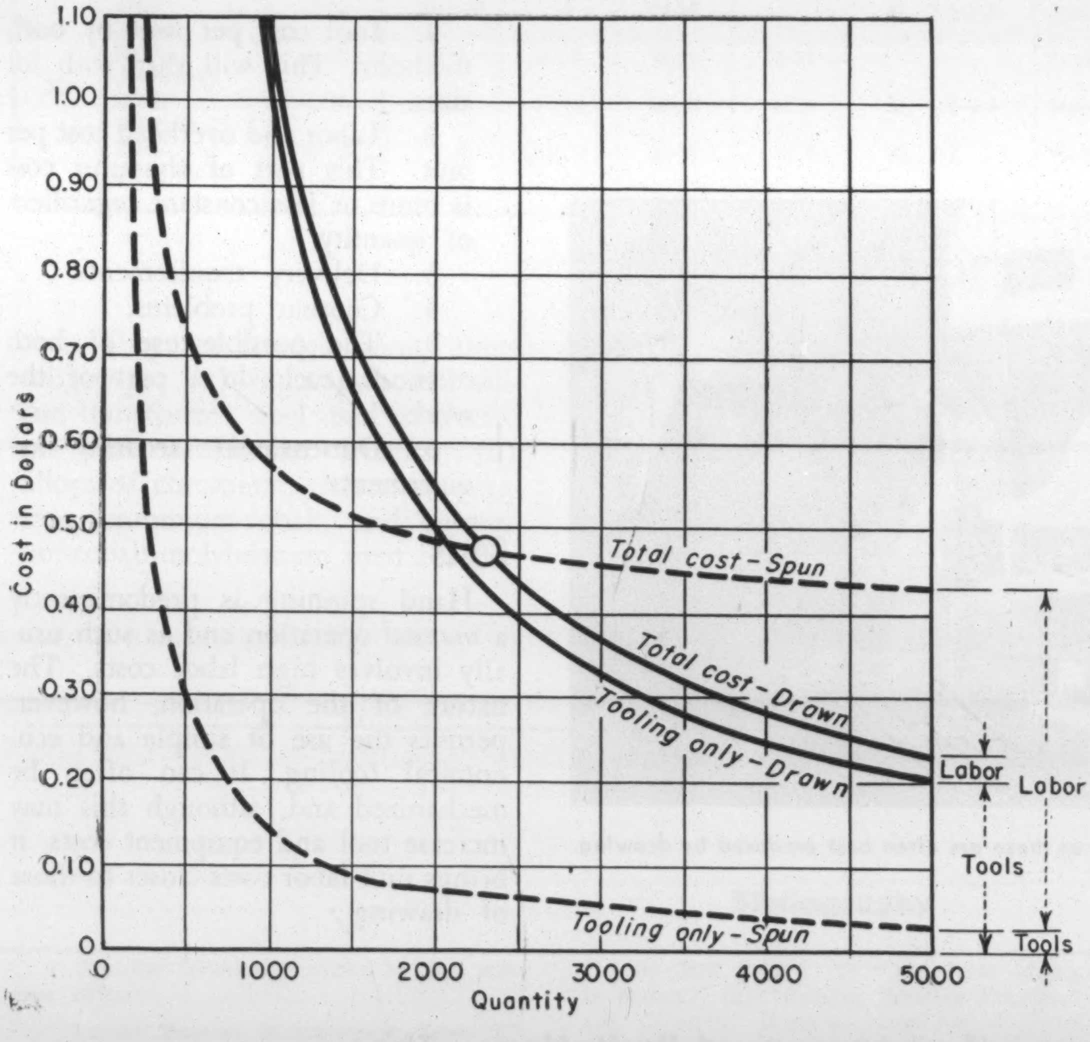


Fig. 1—Unit cost comparison for manual spinning vs. drawing of the same product.

Drawing is a *mechanical* operation capable of low labor costs, but requires more costly tooling. These components of the cost factor must be analyzed in relation to lot size before a comparable cost can be arrived at.

As stated above tool costs vary with quantity, and labor cost is more or less constant. Hence, the total unit cost including tools is largely dependent on the cost of the tools necessary to do the work. Since the variable in both cases is the cost of tools, which in spinning is a low component and in drawing a high component, it follows that the unit cost of a drawn product would drop more rapidly with an increase in quantity than it would with a spun product. However, up to a certain point in the quantity scale the high cost of press tools may bring the unit cost above that of spinning, and it is this demarcation point which must be determined when analyzing the probable cost of drawing or spinning the product.

Table I shows the details of tool and manufacturing cost of an aluminum utensil of 6 in. dia by 6 in. deep. The costs are approximate but are reasonably correct for a product such as this when made by either drawing or by hand spinning.

By plotting all these cost values on a chart (Fig. 1), and superimposing, the pressworking cost values on those for spinning, the demarcation point becomes evident. The intersection of the unit cost curves is the quantity demarcation point beyond which it becomes more economical to draw.

In this particular case the costs are

about the same at 2300 pieces. At 5000 pieces the cost of drawing is about one half that of spinning. Hence, unless other circumstances are present which would affect the choice of method, it would be more economical to spin quantities less than 2300, and to draw quantities above 2300. If the quantity involved was substantial and the shape was one adaptable to mechanical spinning, the effect of mechanization would be to lower spinning costs to a point where they were more competitive and, in some instances, lower than the costs of drawing.

Possibility of future orders. If future orders for a specific product are a reasonable possibility, the economies are changed somewhat. Tooling is usually absorbed on the first order and is not a factor on repeat orders. This would give pressing a decided cost advantage, and the overall effect of including future runs into the calculations is to lower the demarcation point which determines when drawing becomes more economical.

Making use of both processes for a product. Quite often it is possible to arrive at economical costs by using both drawing and spinning to make a shell. Plants regularly making deep drawn circular products usually have a system of standardized tools for breakdown operations which are used for several products. By drawing a blank on a standard set of dies and spinning this drawn shell to its final shape, tool and labor costs can often be reduced.

Other Factors

Delivery—Very often, delivery is a critical factor and production cannot begin until the tools are on hand. The tools for hand spinning can be built in much less time than draw tools, making possible an earlier start on production. However, it must not be forgotten that once the draw tools are working they produce at a much faster rate, and if the quantity is large enough it may be possible to complete the job in a shorter span of *overall* time. This is illustrated in Fig. 2, which shows that up to a certain quantity spinning is competitive from a delivery standpoint, but beyond that quantity the faster production by drawing becomes effective. In other words spinning can go into production earlier because of the shorter tooling time, but when large quantities are involved the faster rate of pressing favorably affects delivery notwithstanding the longer tooling time.

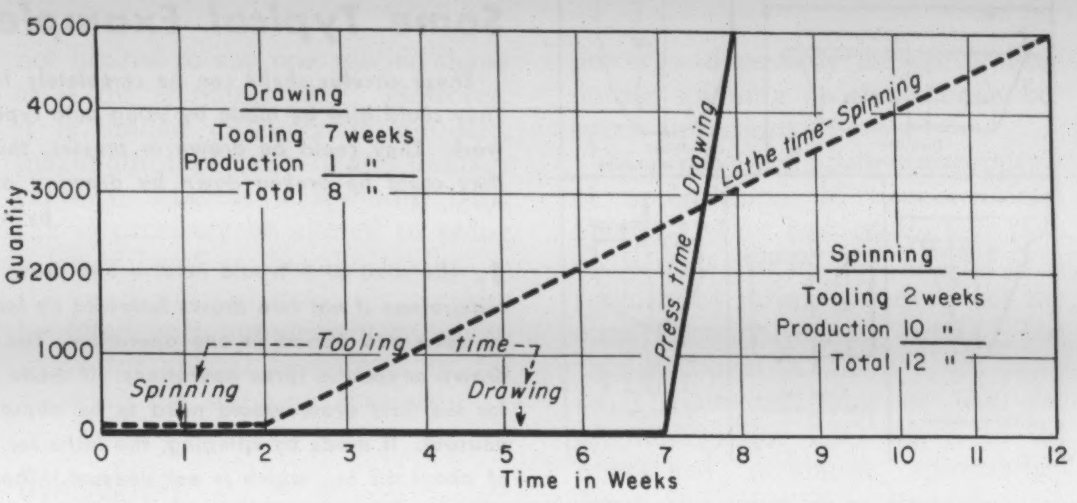


Fig. 2—Time comparison for manual spinning vs. drawing of the same product.

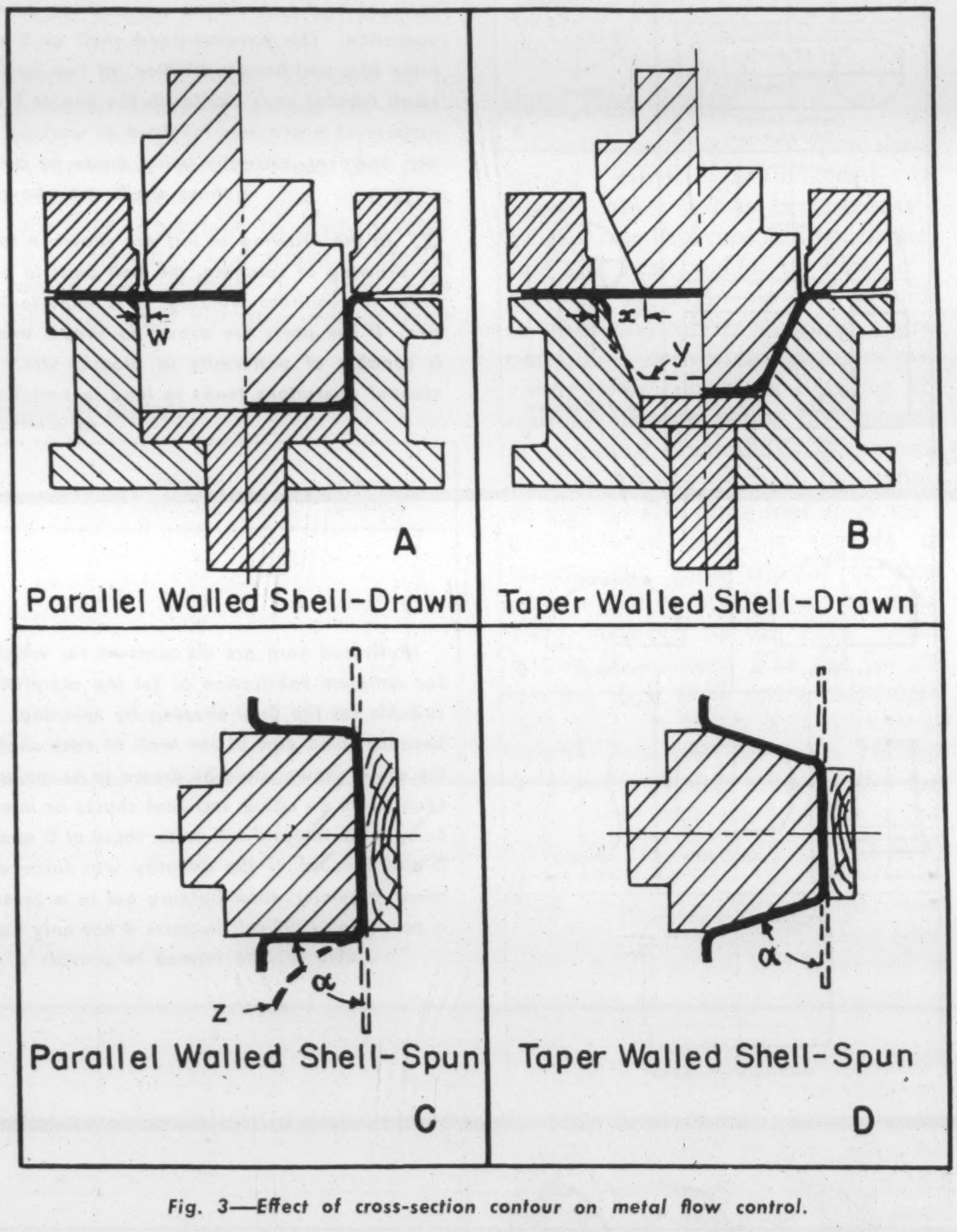
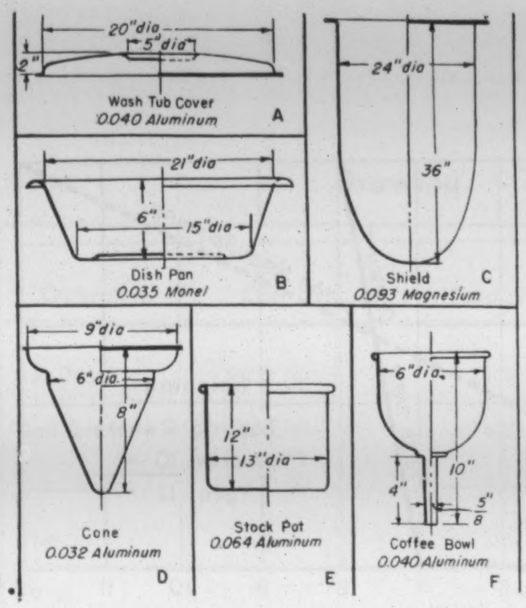


Fig. 3—Effect of cross-section contour on metal flow control.

Contour problems — Re-entrant contours are quite a frequent requirement in such products as kettles, bottle shapes, washing machine tubs, etc., and such contours are usually more easily produced by spinning than by pressing. Re-entrant contours can be spun on sectional chucks or on internal roll units in fewer operations than such shapes can be press formed. It is

Some Typical Examples

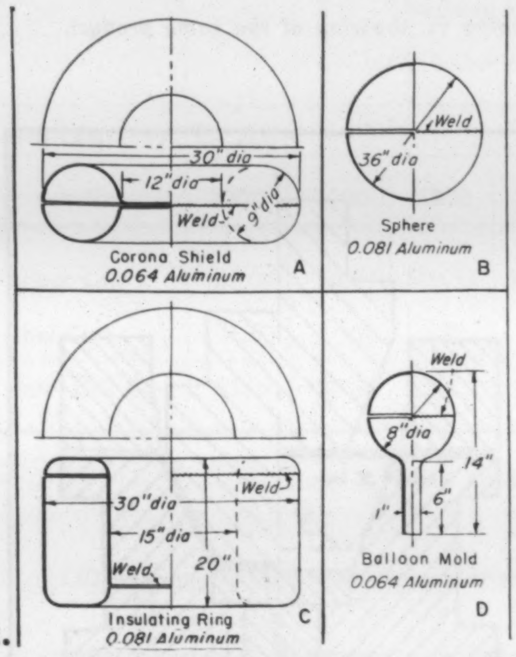
These circular shells can be completely fabricated either by press or spinning methods. They could also be made by using both types of equipment, each doing a part of the total work. They could be drawn in presses, then trimmed and beaded in spinning lathes; or they could be broken down by drawing on standard tools, and finish formed to shape by spinning.


20" dia
5" dia
2"
Wash Tub Cover
0.040 Aluminum
A
21" dia
6"
15" dia
Dish Pan
0.035 Monel
B
24" dia
36"
Shield
0.093 Magnesium
C
9" dia
6" dia
8"
Cone
0.032 Aluminum
D
12"
13" dia
Stock Pot
0.064 Aluminum
E
6" dia
10"
4"
5/8"
Coffee Bowl
0.040 Aluminum
F

1.

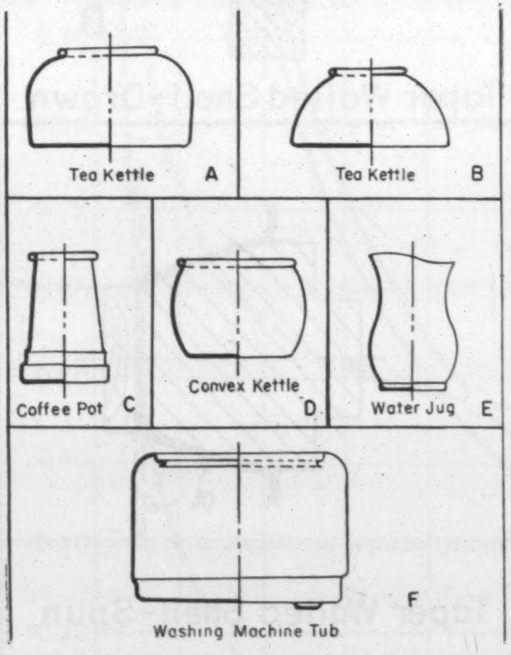
***1.** The shell at A would involve one draw or one spinning operation. The one at B would require one if not two draws followed by lathe ironing if wall finish was critical; or it could be spun and ironed in one operation. The shell at C, requiring a 60-in. blank, could be drawn or spun in three operations. If made on presses, the main ram stroke of the machine for the final draw would need to be about 6 ft. A double-action press of such a size is unusual. If made by spinning, the lathe for the first operation would need to have a swing of about 65 in., which is not unusual. Therefore, spinning would probably be the choice of method for the shell at C, mainly because of the scarcity of suitable press equipment.*

The conical shell at D would require at least eight drawing operations, or possibly three spinning operations. The conical portion of this shell, however, lends itself to automatic spinning and such shapes can and are being produced on special machines in one spinning operation. The parallel-sided shell at E would require two press draws, followed by a lathe trim and bead operation, or two lathe operations if made by spinning. Shells having small tubular ends similar to the one at F are difficult to make in one piece because of the number of operations involved in working the small diameters down to size. Such shapes are, however, currently being made by both the spinning and the drawing processes. All these shells may be described as open contours.

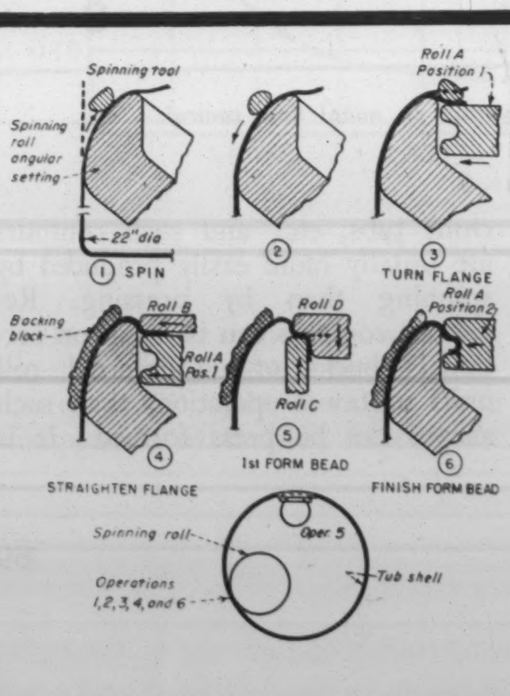

30" dia
12" dia
Weld
9" dia
Corona Shield
0.064 Aluminum
A
Weld
36" dia
Sphere
0.081 Aluminum
B
Weld
30" dia
15" dia
Weld
20"
Insulating Ring
0.081 Aluminum
C
Weld
8" dia
14"
6"
1"
Balloon Mold
0.064 Aluminum
D

2.

***2.** In the drawing at left are shown a few closed contours which can be produced either by drawing or spinning, the half units to be later welded together to make assemblies. In order to facilitate welding, it is important to have the joints well matched in regard to size. If the parts are drawn in shape, matching is no problem because the press method is capable of uniformity in product size. In spinning, the human element of fatigue in manual operations tends to lead to variation; to offset this, the parts should be paired up as production proceeds.*


Tea Kettle
A
Tea Kettle
B
Coffee Pot
C
Convex Kettle
D
Water Jug
E
Washing Machine Tub
F

Illustrated here are six contours for which the spinning process is a logical choice either for complete fabrication or for the completion of shells which have been drawn to a size suitable for the final shaping by spinning. These may be described as re-entrant contours because some part of the wall of each shell is larger than the neck or open end. Each of the shells shown could be drawn to its major diameter, and then have the re-entrant contour spun down on either sectional chucks or internal roll units. The shells at A, D, E, and F can be spun on internal roll units; those at B and C would require sectional chucks. The shells at D and E could, if the quantity was large enough, be made by drawing each shell to its minor diameter, then bulging out in a press to the major diameter. The tub contour at F is particularly difficult because it not only has a re-entrant wall contour, but the top edge is also reverse formed to provide a nest with a rolled edge for the cover.


Spinning tool
Spinning roll angular setting
22" dia
① SPIN
②
Roll A Position 1
③ TURN FLANGE
Backing block
Roll B
Roll A Pos. 1
④ STRAIGHTEN FLANGE
Roll D
Roll C
⑤ 1st FORM BEAD
Roll A Position 2
⑥ FINISH FORM BEAD
Spinning roll
Oper. 5
Tub shell
Operations 1, 2, 3, 4, and 6

Illustrated here is a case in which both pressing and spinning are used to advantage in the production of washing machine tubs. The shells are drawn from 45-in. dia. blanks in two draws to a diameter of 22 in., then the re-entrant contours of the neck are spun. The six steps necessary to spin and bead the turtle neck tub shape are shown. These six steps are all part of one operation and the entire sequence is gone through without moving the roll unit. The angular setting of the spinning roll was necessary because of the recessed top flange.

difficult and sometimes impossible to provide internal support for the metal being necked-in on a press tool whereas a sectional chuck or an internal roll provides full support while spinning and makes it possible to produce a smoother finish on the work.

Dimensional Accuracy — Greater accuracy of size and wall thickness and better uniformity are possible on drawn work than on spun work. A tolerance of $\pm$ 1/32 in. is as close as can be guaranteed on a hand spun product. These limits for spinning however, can be improved when the spinning tools are mechanized. With hand spinning, the human element is a predominating factor and much depends on skill and experience. Wall thickness variation in a spun product is largely a result of inexperience. Fatigue is another factor applicable to manual operations and is often reflected in the quality and quantity of work produced.

Capacity limitations—The press is not limited to any one specific shape as is the spinning lathe. However, it is limited to a certain die size, maximum drawn depth, and tonnage capacity, whereas a spinning lathe can if necessary be altered to swing a larger blank by merely jacking up the head and tail stock. It can also be fitted with supplementary equipment for special operations or for boosting the spinning pressure.

Spinnability

The question naturally arises, "What metals can be spun?" Spinnability is directly proportionate to ductility, and a metal which can be deep drawn can usually be deep spun. This fact may be used as a guide in selecting metals for spinning. The high formability possible by spinning results from the progressive nature of the operation which is equivalent to many successive drawing operations. Metals which are difficult to draw may often be spun but may require more power, and possibly the use of heat during spinning or else anneals between operations.

In order to tabulate the property of spinnability, Milwaukee Metal Spinning Co. has conducted tests on various metals and arrived at a spinnability rating for several of the more commonly used metals. The ratings shown in Table 2 are based on a numerical value of 1.00 for aluminum alloy 2SO which in the tests had maximum spinnability. From the table it is seen that, although some of the metals which have good deep drawing properties are also high in spinnability, others which are difficult to draw have fair spinnability.

Table 2—Spinnability of Metals

	Shallow Spinning	Deep Spinning
ALUMINUM AND MAGNESIUM		
Alcan 2SO & 3SO Aluminum	1.00	1.00
Alcan 57SO & 55SO Aluminum	.98	.62
Alcan 17SO & 24SO Aluminum	.65	.45
Magnesium & Dowmetal	.55	.45*
SOFT METALS		
Zinc	.94	.94
Pewter	.94	.93
Lead	.90	.85
STEELS		
Cold Rolled (deep drawing steel)	.91	.91
Hot Rolled (pickled drawing steel)	.91	.72
Lead Coated (long ternes)	.90	—**
Galvanized	.82	—**
High Tensile Steel	.40	.13
40% & Upward of Carbon	.22	.09
COPPER AND COPPER ALLOYS		
Commercial Bronze	.87	.87
Copper (cold rolled annealed)	.87	.87
Yellow Stamping Brass	.86	.86
Nickel Silver (up to 30%)	.85	.75
Phosphor Bronze (soft Temper)	.73	.39
Muntz Metal	.47	.13
NICKEL AND NICKEL ALLOYS		
Nickel	.86	.86
Monel (deep drawing quality)	.86	.82
Inconel	.81	.75
STAINLESS STEELS		
Type 347 (18/8)	.67	.67
Type 430 (14/18)	.67	.53
Type 304 (18/8)	.65	.65
Type 302 (18/8)	.65	.33

* *Special set up for hot spinning.*
** *Coating will flake.*

Metal Flow Control

Considering drawn or spun shells having either parallel-sided or tapered walls, it may be stated as a general rule that contours which provide the best control of flow in a drawing operation do not provide as good control in spinning operations; and, conversely, contours providing poor control in drawing operations provide better flow control in spinning operations. The reason for this may be clarified by a study of Fig. 3. The draw tool at *A* for a parallel-sided shell is capable of maintaining good control of flow because only a small band of metal (*W*) adjacent to the draw radius is free to wrinkle. The die for the tapered shell at *B* has a substantial area (*X*) on which it is difficult to prevent wrinkle formation because it is out of contact with the die surfaces for a large part of the operation. In fact it is not under complete control until the draw is almost completed. On a taper such as this, a preliminary drawing operation indicated by line *Y* would be advisable to improve the control of metal flow.

These two shapes reproduced again at *C* and *D* in a spinning operation show that in both, the metal has to be moved through space before reaching the support of the spinning chuck, and the tapered shape moves through a shorter arc than the parallel-sided shape; therefore, it is under better control. Normally an extra breakdown spinning operation would be used as indicated by line *Z* to assist control of flow in producing parallel walled shells.

Adapted from a paper presented at the 1953 meeting of the American Society of Tool Engineers.

Typical Beater-Saturated Fiber Sheet Materials

Type	Composition	Compression Range* 1000 psi-1 min.	Tensile Str., psi minimum		Characteristics
			AMD	MD	
CS-301	Cellulose fiber, cork, and Buna S	30-45%	800	900	A dependable seal in water and oil and in other services not involving aromatic fuels and certain solvents.
CN-705	Cellulose fiber, cork, and Buna N	30-45%	1,000	1,200	Generally suitable for oil, gasoline, and water services.
CN-707	Cellulose fiber, cork, and Buna N	20-35%	1,200	1,500	Designed to hold high internal pressures with lightweight flanges.
AN-702	Asbestos fiber and Buna N	25-35% (5,000 psi-1 min.)	2,000	2,800	Specially treated for extra resistance to aviation fuels, oils, and coolants.

** Tested per ASTM D1147-51T.*

New Paper Materials Find Use in . .

by **E. C. FRAZIER**, Manager, Sales Research Dept., Industrial Div., Armstrong Cork Co.

● A NEW FAMILY of paper materials composed of combinations of fibers, synthetic rubber or resins, and sometimes ground cork, have been developed by Armstrong Cork. Compositions can be varied at will to produce a wide range of strengths, densities, thicknesses and other properties. In appearance, the new materials can resemble soft felts, stiffer felts or papers, and even rigid hard boards. The big advantages are greater strength and water resistance than comparable conventional fiber materials. High compressibility is combined with high crush resistance, imperviousness, flexibility and uniformity. Applications have been found in gaskets, automobile oil filter elements, embossed vinyl-covered decorative sheet and coating papers for use in industries such as the luggage and handbag trades.

How Produced

The new materials are made by a modification of the beater-saturation process. The wool or cellulose fibers are first treated in large beaters with water dispersions of rubber or resin. Ground cork, if required, is treated in the same solution as the fibers. The resultant slurry is pumped on to a moving screen of a Fourdrinier paper making machine. The water drains off, leaving the coated fibers and/or cork to felt or mat together to form a continuous sheet. Press rolls, drier drums and a calendar complete the processing.

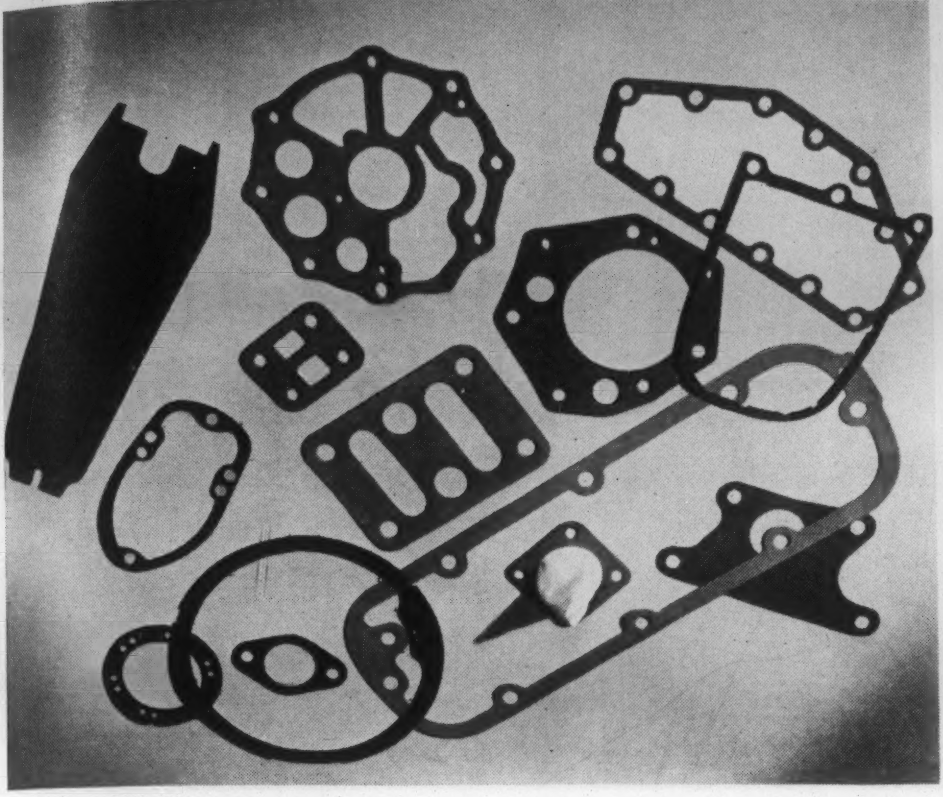
This is an entirely different process from that used to make solution saturated papers. These are made by passing dry, absorbent papers through a saturating bath. When this method of *after* saturation is used, the paper must be soft and porous to absorb the saturant. This severely limits the properties of the finished material. Beater saturated materials can be tailor made to requirements of use. In conventionally saturated paper there is also a tendency for the rubber to concentrate on the surface. In these new materials, the rubber-fiber ratio is constant throughout.

Available Compositions

The process itself is what is new here, rather than any one particular material. The perfected beater saturating process can use a wide range of fibers, rubbers and resins. Cellulose, wool asbestos and even some ceramic fibers can be handled. Any rubber or resin that is available in water dispersion form is a possibility. Most of the materials made commercially so far have been combinations of synthetic rubbers, mainly GR-S and nitrile types, and cellulose fibers, with or without ground cork. As applications are found, new formulations can be put into production. Phenolic resins are used, but with some difficulty, because of solubility in water. Silicone rubber dispersions are still in the development stage.

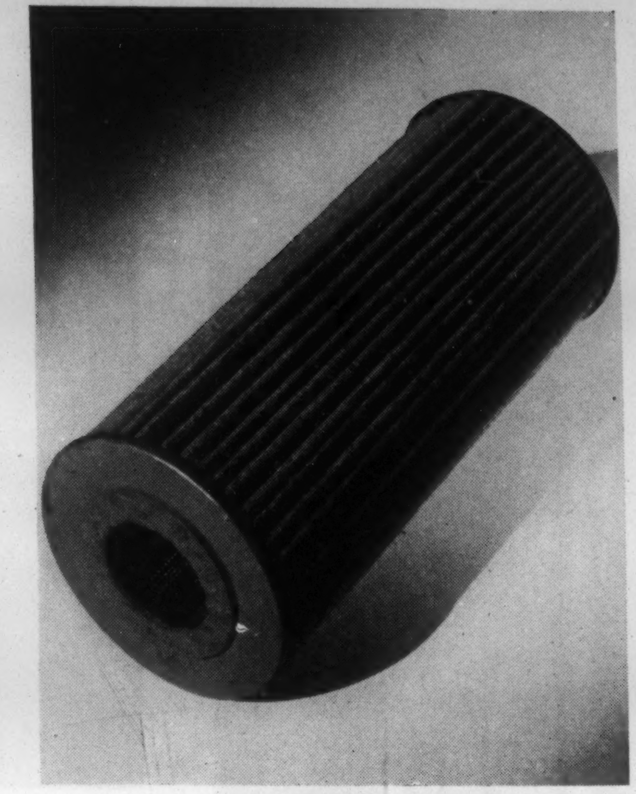
Because of the intimate dispersion of rubber or resin, these materials tend to be stronger than conventional materials of similar composition. Phenolic-fiber compositions are used in automobile oil filter elements requiring higher wet strength, for example. Crease and crush resistance is high, since the fibers are held in place by the binder. These materials are more water resistant than regular felts and paper, because of the protection given the fibers. Stiffeners for cap peaks are a succesful application. These products are not waterproof, however, and will respond slightly to atmospheric moisture conditions. Rubber does add to their imperviousness and gives additional resiliency.

One interesting property is exemplified by the hot-embossing materials recently developed. Conventional felted papers do not emboss successfully since they will not hold the lines permanently. Felts beater-saturated with GR-S, on the other hand, hold intricate patterns. The rubber molds under the heat and holds the board in the impressed



. . . . Gaskets

—GASKET MATERIALS, above, are made of cellulose fiber sheets with Buna-S or Buna-N and ground cork. Others containing asbestos withstand up to 750 F.



. . . . Oil Filters

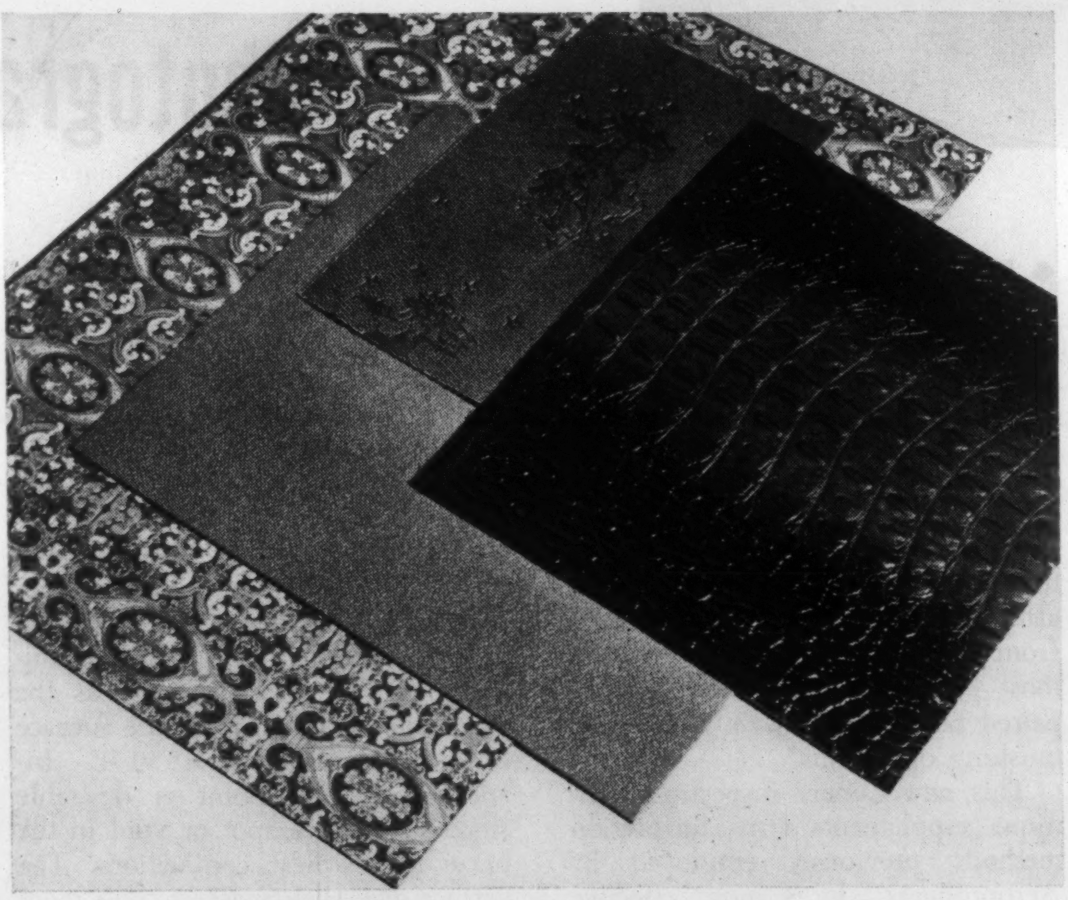
—AUTOMOTIVE FILTER ELEMENTS use new paper materials produced by a modification of beater-saturation process.

shape. Vinyl covered decorative panels for automobiles can be made in this way.

Gasket Materials

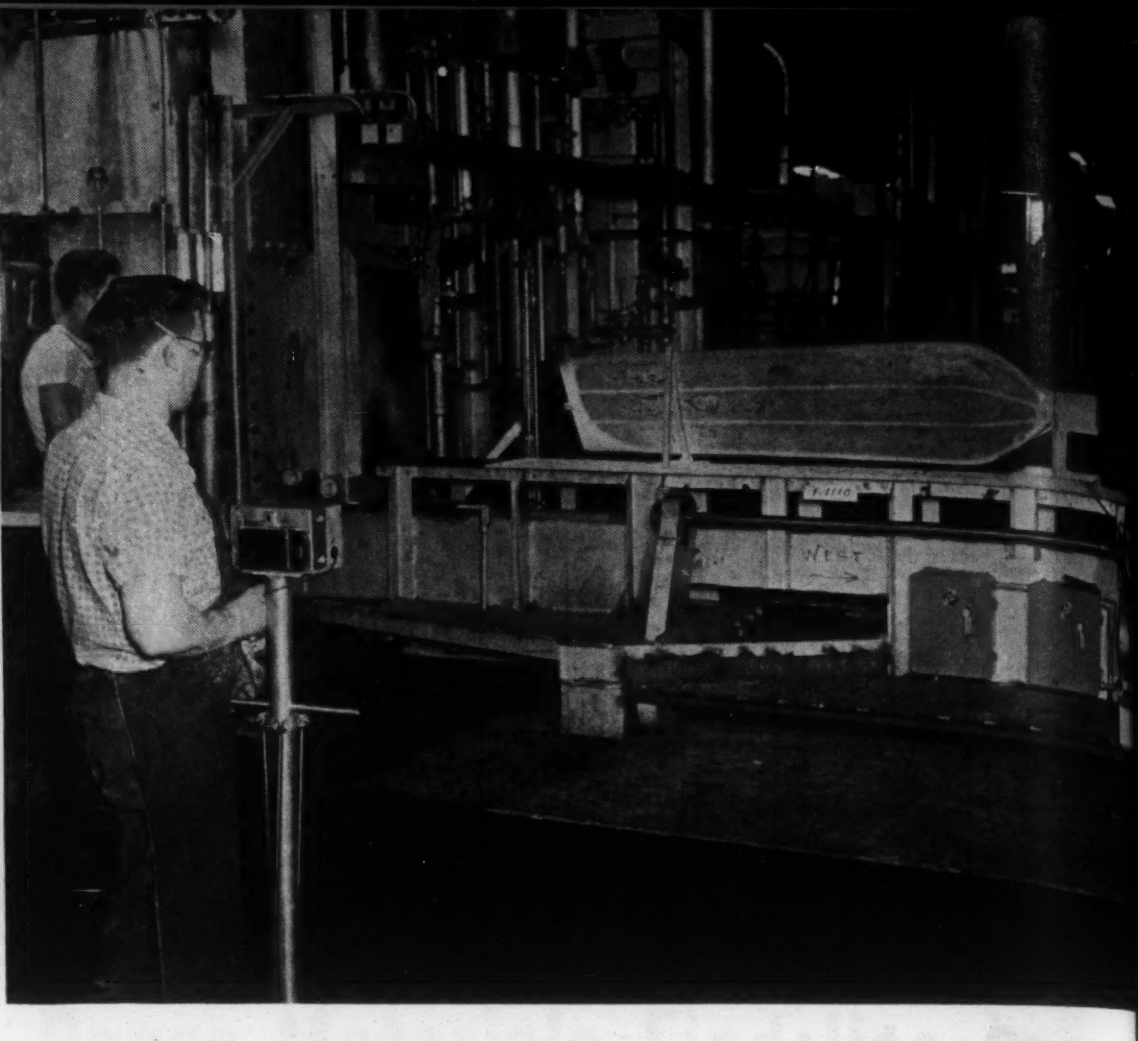
The beater saturated gasket materials made so far are known commercially as Accopac. These are cellulose fiber sheet materials with Buna-S or Buna-N and ground cork. The cork gives high uniform compressibility. The material is thus effective as a gasket on light or heavy flanges. Dimensional stability is excellent. The binders are not affected by humidity and there is no permanent shrinkage. The rubber is nonvolatile and cannot be leached out. Unlike glue-glycerine materials, Accopac crush resistance is extremely high. Pressures up to 100,000 psi can be taken. (Conventional fiber materials often fail at 25,000 psi.) The handling qualities are excellent and gaskets do not crack or pipe easily when accidentally bent. None of the constituents in the material encourages corrosion of steel, aluminum or magnesium flanges.

Another type of Accopac uses asbestos and Buna-N. This is used for gaskets operating up to 750 F. It is an improvement on conventional asbestos rubber packing. Compressibility is higher. The new material is homogeneous and non-directional, having no clumps of dry asbestos. This material can sometimes be used in gaskets for applications in which the rubber disintegrates at the high operating temperatures. The asbestos fibers are so uniformly distributed and interlocked that they form an acceptable gasket without the rubber.



. . . . Embossed Sheeting

—EMBOSSED VINYL-COVERED SHEETS made of the new papers are used for such things as luggage and handbags.



***BRAZED STEEL PROPELLER BLADES** are photographed by camera mounted in box on tubular standard (left) as they are withdrawn from heat treating furnace (above).*

Photographic Inspection

● PHOTOGRAPHS OF red-hot steel airplane propeller blades are enabling inspectors to more quickly and accurately detect imperfections in brazing and thus save time and reduce waste at the Dayton, Ohio, plant of Aeroproducts Operations, Allison Div. of General Motors Corp. Such photographic inspection techniques, employed immediately after propeller blades are removed from heat-treating furnaces, enable most defects to be located and repaired before the blades reach final finishing operations.

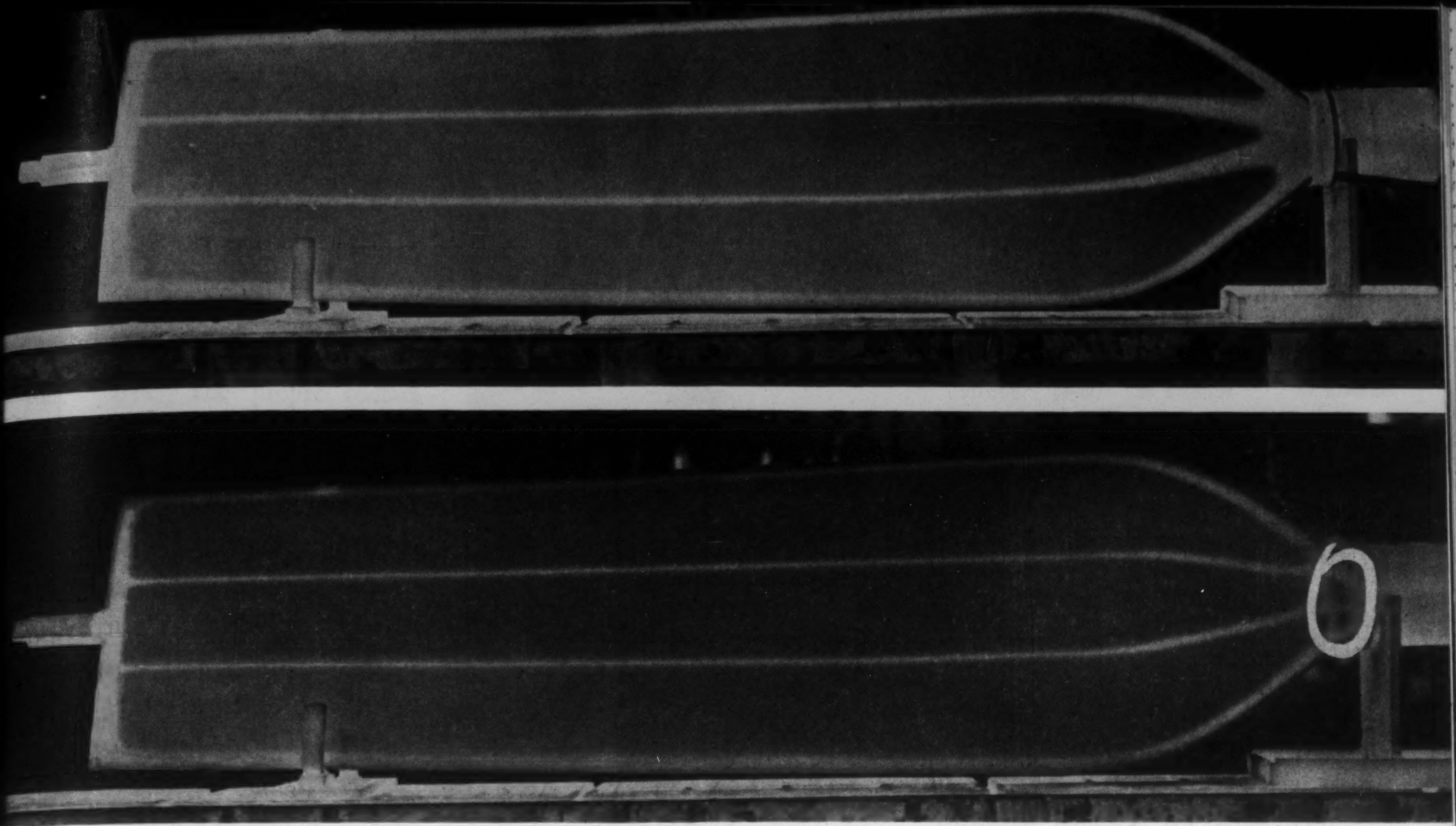
This new camera inspection technique supplements visual inspection methods previously employed by Aeroproducts. It is more effective than visual inspection because in a fraction of a second, the camera can record the overall appearance of 10½ foot long blades at the instant when they are best suited for such inspection. It produces a permanent record which is not subject to human error or affected by the intense heat.

The need for inspection of propeller blades stems from the fact that perhaps one of the most critical operations in the production of such blades is the brazing together of two longitudinal sections to form the hollow blade structure. Failure to achieve a firm bond at all points in the braze would leave a weak spot that might break under the severe stresses to which propellers are subjected.

It has been standard practice at Aeroproducts to make a first examination of the braze visually as the blade is withdrawn from the furnace after heat-treating at 1550 F. Inspection at this point is desirable since a defective spot or void in the braze affects heat conduction. The surface over such a defect cools more rapidly than the area where the brazed bond is good. Thus, any defect is visible as a dull spot on the glowing surface.

Photographic inspection techniques were adopted because as the blades kept growing bigger, visual examination became more difficult. Scanning a large brazed area visually in the brief interval during which observation is possible, and in the face of the intense heat, was hurried and uncertain.

This problem was brought to the attention of the plant's photographic department, and it was suggested that visual observation of the hot blades be supplemented with photographs. This suggestion has been carried out, and now every 10½ ft blade is photographed as it is withdrawn from the furnace. After processing, the negatives are projected to full size, and the images scanned carefully for evidences of voids. If such a spot is found, its size, shape, and location can be quickly plotted. From this, a determination is made as to whether the blade can be repaired or must be scrapped. Since approximately half of the manhours required in the manufacture of the blades are in subsequent operations, the savings in time derived from detection of voids at this stage, rather than after many hours have been expended in finishing operations, are considerable.



IMPERFECTIONS IN BRAZING are readily visible on the photographs of hot blades (bottom). Good brazed joints are shown in photograph at top.

Spots Defective Brazing

by **M. A. SLAIRETAM**

How It's Done

The photographs of the blades as they are withdrawn from the heat-treating furnaces are taken by a Kodak Medalist camera, fitted with a 2¼ x 3¼ in. film pack adapter. The camera has been permanently fixed inside a sturdy box made of heavy aluminum plate, and the box is mounted on a tubular standard that holds the camera on the same level as the blade rack. Several floor receptacles to accommodate the standard have been installed, so that the camera can be moved from one furnace to another. Each receptacle is so located that the lens-to-blade distance is exactly 11½ ft in each case. The camera focus has been fixed at that distance, and can be changed only by disassembling the box. The cable release has been attached to the lens cap, so that the operator cannot forget to remove the cap before tripping the shutter.

Kodak Plus-X film packs are used for these photographs to provide fine grain and high sensitivity in the red portion of the spectrum. The only illumination is the normal factory lighting, and the glow of the red-hot blade. Exposures are made at f/3.5 for 1/25th of a sec. The film is developed in D-76 developer for 30 min.

The exact instant of taking the photograph is determined by the inspector at the furnace operation. Upon withdrawal of the blade from the furnace, he plays an air hose over it for about 25 sec to produce the right amount of cooling for optimum delineation of any "cool" spots. When he believes the blade is at the proper stage of cooling, he signals a member of the crew, who makes the exposure.

The serial number of the blade, the date, and other pertinent information, are lettered on cards which are taped to the rack, facing the camera, so those data also become a part of the photographic record at the same time.

A time schedule has been worked out which allows the photographic department four hours between the time the blade is photographed and the time the negative must be delivered to the inspection department. This schedule allows ample time for dark-room processing of the film in batches. At the same time it is sufficiently rapid so that production is not delayed; for after heat-treating, each blade goes through an 11-hr shaping and cooling cycle, during which time it cannot be worked.

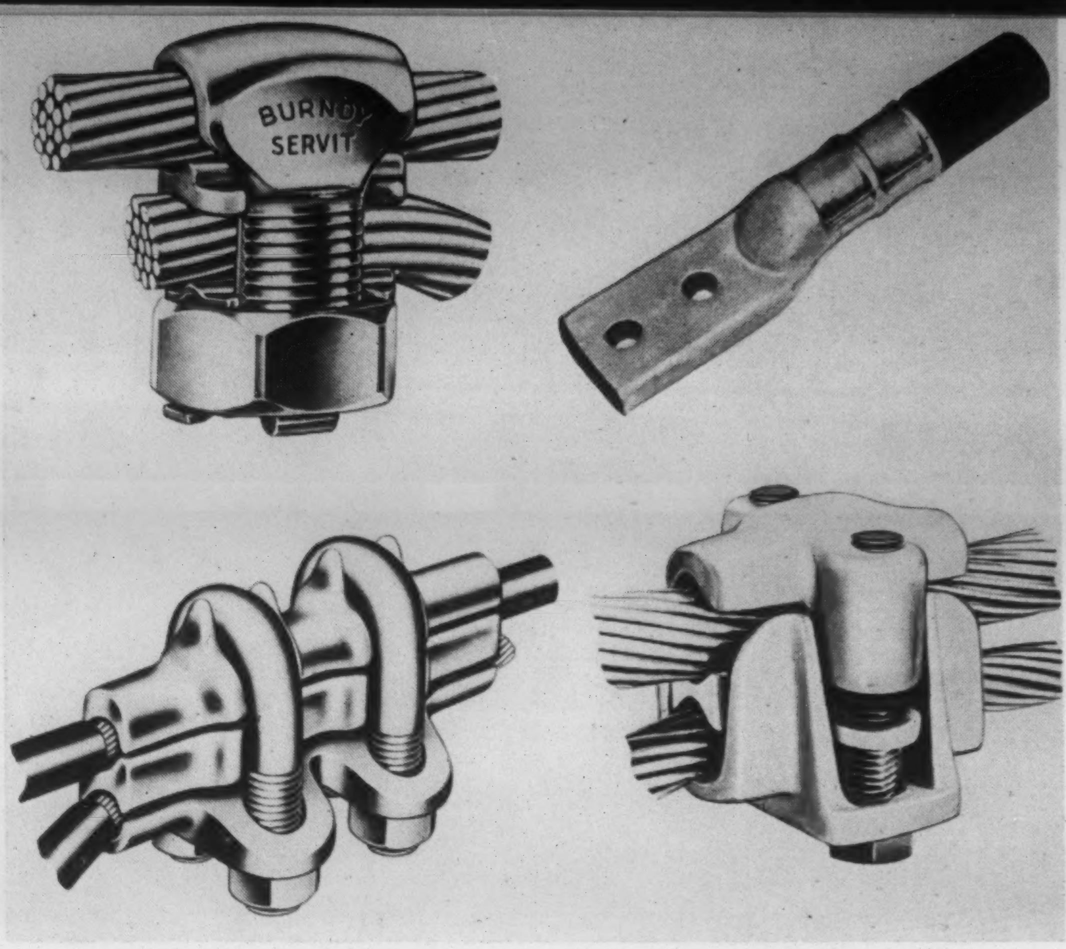
Although the experience with this photographic inspection technique has not yet been extensive enough to make possible an accurate determination of savings in terms of time saved, and waste eliminated, the inspection department is satisfied that such savings have been substantial. At the same time, the negatives become a valuable part of the permanent records of the processing of each blade, available for reference should there ever be future occasion for studying the performance of the blade.

How to Select Connectors for Aluminum Conductors

by HENRY DUPRE,

Chief Development Engineer,
Burndy Engineering Co., Inc.

Aluminum's entrance into the electrical field has created many joining problems. For insulated cable, a successful solution has been designing or adapting connectors specifically for aluminum.



Typical connectors for aluminum conductors.

● ALUMINUM IS becoming more and more favorably looked upon as a conductor. Conductors used in transmission, and in some cases distribution, have for many years been made of a composite stranding of aluminum and steel (ACSR), but connector problems encountered were limited and pertained essentially to splicing and dead-ending. The problems today have been created by the introduction of aluminum as insulated conductors in buildings and underground distribution. This has forced a re-examination of many factors including:

1. Physical design of the connector, with respect to such factors as cold flow, tensile strength, and corrosion.
2. Effect of electro-galvanic action between copper and aluminum.
3. New test procedures in order to properly evaluate design results including the development of heat cycling and interstrand resistance tests.
4. Space factors when the fitting is located in a box, vault, or other location which may have been designed for copper conductor.
5. Effects of overloads on aluminum connections.
6. Re-education of electricians and field crews.
7. The need for Underwriters Laboratories listing of these

Compression-installed tinned copper splice joins aluminum-to-aluminum and copper-to-aluminum in this aluminum wound fractional horse power motor.

new conductors and fittings.

8. Evaluation of the connector for the particular application.

Design Considerations

Connecting aluminum to aluminum presents a problem of designing for proper strength, conductivity, and contact area. The proper contact area cannot be readily calculated, as it is not a unit ratio of the area of cable in contact with the terminal to the cross-sectional area of the conductor. Relaxation of the conductor and connector material cannot be neglected by making the assumption that overload currents and high temperatures would not effect the joint. The heating of the connector by overloads will have a very definite effect on the hardness of both conductor and connector.

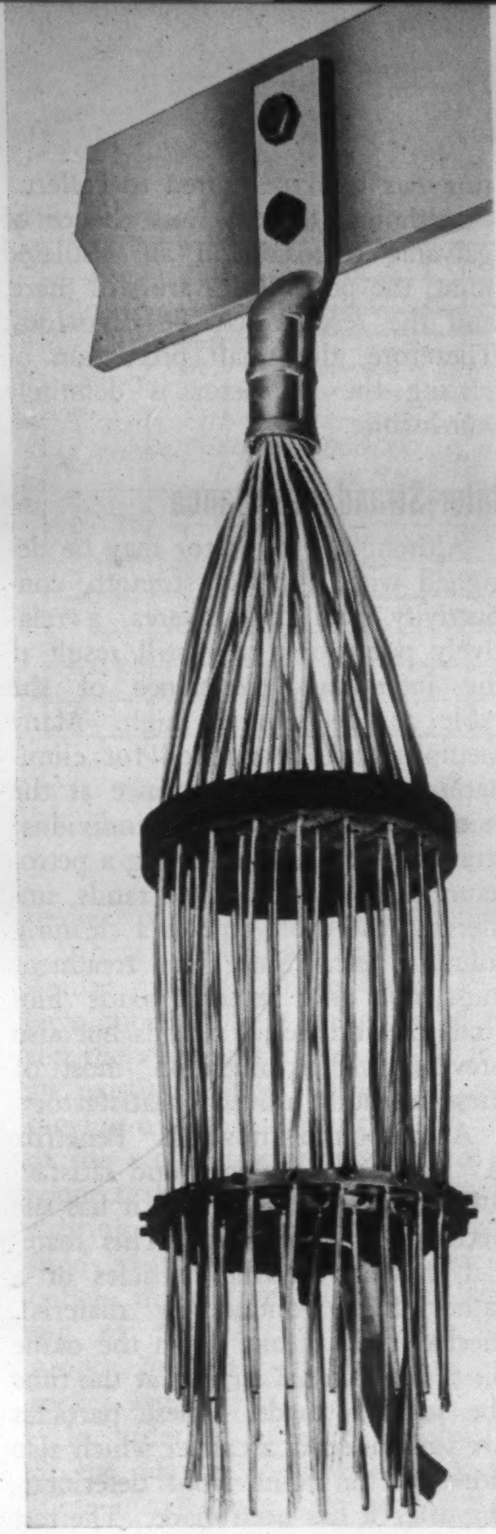
In addition, aluminum is subject to cold flow. By calculating the contact area simply on the cross-sectional area theory, the high contact pressures necessary would cause the material of both the connector and the conductor to cold flow, thereby permitting a relaxation of the pressure between the connector and the conductor. This relaxation can be eliminated by making the contact area large enough to result in a relatively low pressure on the conductor.

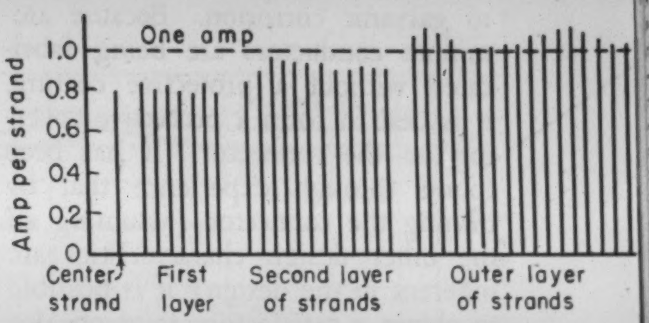
Therefore, when designing the contact area of a connector, one must keep in mind these three considerations:

1. The contact area must be sufficiently large to reduce the element of cold flow to a negligible amount.
2. The area of contact must be sufficiently large so that overloads, which of necessity must elevate the temperature of the joint do not result in a loose connection caused by the annealing of the material.
3. The connector must have a contact area large enough to withstand the mechanical stress on the connection.

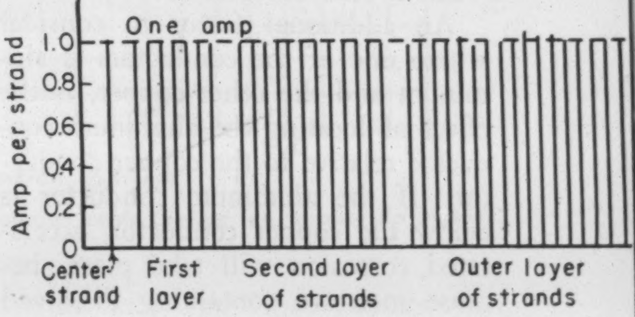
These three factors can best be evaluated by means of tests which can determine the characteristics of the connection. It is evident that certain types of connectors, such as compression joints, do not involve the same considerations as clamp type or bolt type connectors. Because of the lower current densities, a connector for use in light duty applications does not require the same consideration as a connector intended for use in heavy duty applications. It is the responsibility of the connector manufacturer to evaluate these considerations correctly, and to determine the proper ratio of area of contact to cross-sectional area of conductor.

Where dissimilar metals are employed, it is possible to get a combination of cold flow and mechanical failure as a result of repeated heating cycles. The aluminum may expand faster than the connector material, thereby creating high pressures which in turn will force the aluminum to creep longitudinally in the joint. In addition, the high pressures may also tend to deform the body of the connector. By properly designing the fitting, it is feasible to have the connector breathe during the heating and cooling cycles, so that no permanent damage occurs.





WITHOUT "PENETROX A"



WITH "PENETROX A"

Interstrand resistance test set-up (left). Charts (above) show distribution of direct current in strands of 37-strand 500 MCM aluminum cable indented in aluminum terminal with and without Penetrox compound. (Total current 37 amp).

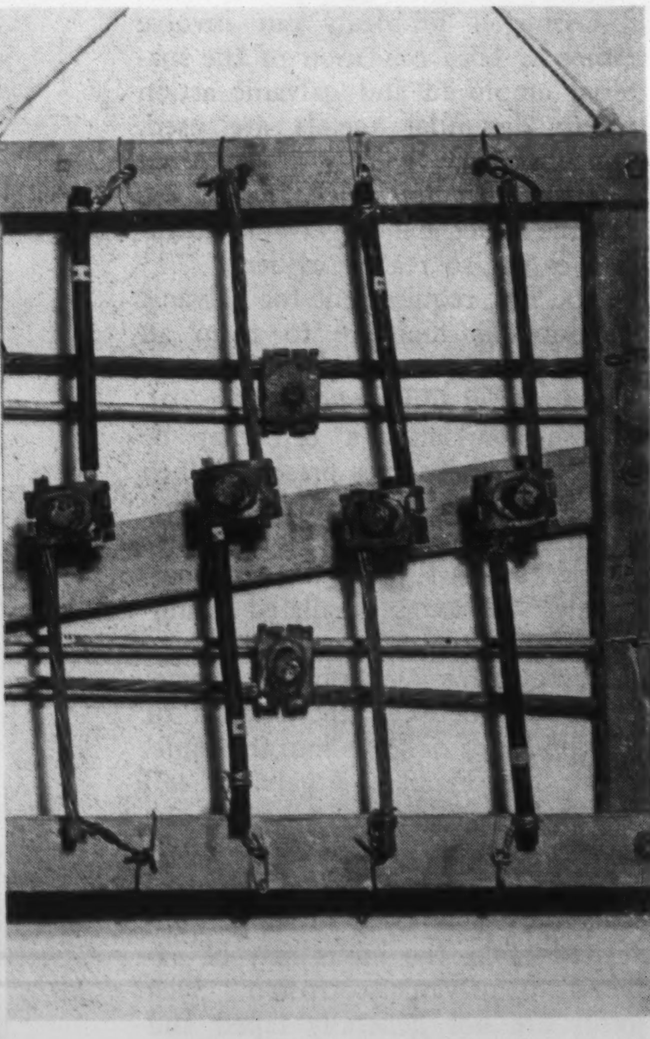
Corrosion Problems

Corrosion problems can involve either or both oxidation of the material employed and galvanic action where dissimilar metals are used. Oxidation is a generally recognized problem and precautions are taken. On the other hand, galvanic corrosion is not so readily evident.

The first requirement for galvanic corrosion is moisture to form an electrolyte. Where the connector is of a material different from the aluminum conductor, a cell may be formed if moisture is present. When using insulated conductors, general practice is to tape the joints after they are made to insulate them completely. Although insulated aluminum conductors are less subject to galvanic corrosion, moisture sometimes gets between the strands of the conductor or seeps into the cable. When this happens a galvanic cell may be formed even though the joint is completely taped.

Where aluminum neutrals or messengers are employed to support insulated cable, the joints may be exposed to galvanic corrosion. Such joints are not generally taped and are thus open to the elements. This problem can be solved by coating either the connector or conductor with a metal which is less subject to galvanic corrosion. Because aluminum conductors are being fabricated without a protective coating, it is best to form a protective covering on the connector. It has been found through experience that by tinning the connector (assuming all the other design characteristics are inherent in the design) it is possible to obtain a satisfactory joint on aluminum cable. The same connector can also be used on copper cable without fear of corrosion.

An additional factor to consider where one of the conductors is aluminum and the other copper, is the effect of locating the aluminum conductor relative to the copper conductor. If the aluminum conductor is below the copper conductor, accelerated corrosion will take place, because moisture containing dissolved copper salts will collect in pockets forming a "bridge" of electrolyte between conductors. Accompanying illustrations show a test rack with the results of a salt spray corrosion test on a typical joint. Note the type of corrosion which occurs and also note the fact that the corrosion is most accelerated where the moisture has been permitted to collect.



Corrosion test rack illustrating a clamp type fitting with the aluminum conductor either above or below joint with sample mounted either vertically or horizontally.

Although there is less chance of galvanic corrosion in an insulated joint, the possibilities are still there, and the results may be disastrous. Therefore, the small precaution of plating the connector is definitely worthwhile.

Inter-Strand Resistance

Although a connector may be designed with sufficient strength, conductivity, and contact area, a relatively poor joint may still result if the inter-strand resistance of the cable at the joint is high. Many methods have been tried for eliminating inter-strand resistance at the joint: cleaning each individual strand by abrasion, inserting a petroleum paste between the strands, immersing the cable end in a cleaning solution, etc. Since the treatment must not only remove oxide film from the individual strands but also prevent further oxidation, most of these methods proved unsatisfactory.

A compound known as "Penetrox A" has been developed and satisfactory test results show that it has the necessary qualifications. This material, having metallic particles of a rather high conductivity material, mechanically breaks down the oxide on the individual strands at the time the joint is made. These particles are suspended in a carrier which also prevents the joint from deteriorating after it has been made. The test used consists of passing current through every strand in the joint, and checking the current distribution in the cable by measuring the current in each individual strand, using the millivolt drop method.

Industrial Applications

When aluminum cable is employed in industrial applications, additional factors must be considered. Aluminum cable used in such applications must be terminated in junction boxes and switch-gear which have been designed for terminating copper cable. This presents a problem because, in many cases, aluminum cable will require slightly more space and larger entrance openings into the equipment. However, higher heat resistant cable insulation may be used to permit the same overall diameter of aluminum conductor as of copper.

Where a connector is to be used under severe vibration, a vibration test should be performed. This test, and the Underwriters Laboratories secureness test, are of a special nature, and are generally performed on connectors with a definite use in mind.

The most important problem which may be encountered in industrial applications results from the

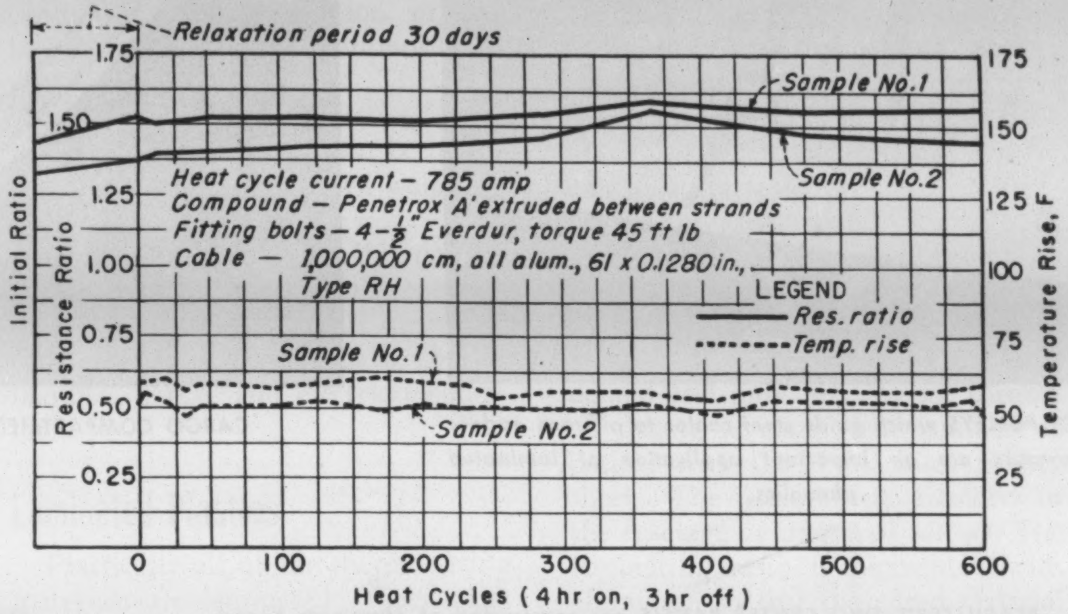
Re-Education Also Needed

The introduction of insulated aluminum cable into the industrial and utility fields will of necessity require a re-education on the part of the splicers and electricians working with this cable. Utilities will have less of a problem because of the more stable nature of the labor employed by them. It is easier for a utility to train a crew to operate and perform according to established standards than it is to train electricians who are hired by contractors for performing a given installation job. The utility men must live with the installation after it has been in operation, whereas the contractor's liability is not as direct.

This re-education does not involve a great deal of work because there is very little difference between an installation on aluminum cable and one made on copper cable. However, if the connector employs aluminum bolts instead of some of the more conventional hardware, a slightly lower tightening torque should be used. If compression tools are to be used, a new and different type of installation technique will be necessary, and the splicers will have to be instructed as to the die combinations necessary for making the connections.

The use of a compound for the purpose of breaking down the inter-strand resistance of the cable will also be a new operation which the electrician will have to become accustomed to. When using bolted type fittings, this compound will have to be inserted in between the strands and smeared on the surface of the outer strands prior to the installation of the connector on the cable. One fitting manufacturer has relieved the electrician of this responsibility when using compression type fittings, by filling the inside of the connector barrel with the compound so that, upon inserting the cable into the barrel, the compound is forced between the strands.

In addition to becoming accustomed to performing these new duties, the electrician must also become trained to differentiate between terminating clamps which are proper for use on aluminum and those which have been designed strictly for use with copper.



Heat cycle test of fittings for 1,000,000 CM aluminum cable (bolted lug, copper tin plated).

fact that the equipment comes furnished with connectors right at the terminating point. Thus, the only operation necessary by the electrician is the stripping of the cable and the insertion of the cable into a mechanical clamp of rather short contact length, with resulting high unit pressure. The other point to be considered is that connections at these points may often be subjected to considerable heat. These conditions must be analyzed, and in most cases a modification of terminating points will be necessary before aluminum cable can be employed.

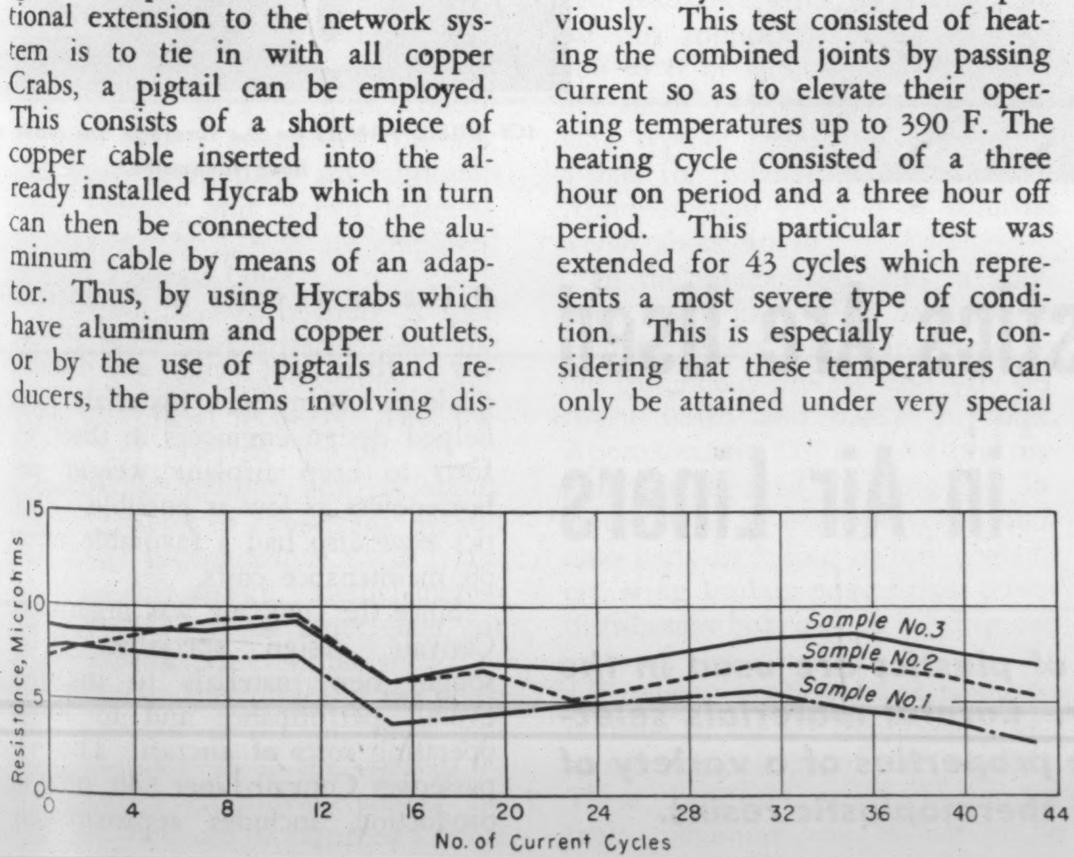
Adaptability

In applying aluminum cable to underground distribution systems, which represents the heaviest current loading condition, two additional problems present themselves. Because of possible fault conditions in network systems, temperatures of 390 F or more can be anticipated. This will completely anneal the cable and connector joint with a great deal of relaxation taking place in the inherent forces present in compression joints. The second problem presents itself when this aluminum cable is tied in with existing copper networks.

Where Hycrabs are employed, it is possible to design the Hycrab with an assortment of copper and aluminum outlets depending upon the specific requirement. If the additional extension to the network system is to tie in with all copper Crabs, a pigtail can be employed. This consists of a short piece of copper cable inserted into the already installed Hycrab which in turn can then be connected to the aluminum cable by means of an adaptor. Thus, by using Hycrabs which have aluminum and copper outlets, or by the use of pigtails and reducers, the problems involving dissimilar conductor materials is solved.

Where Moles are employed a similar method can be used. Tests have shown that it is unsafe to insert the aluminum cable directly into an existing copper Mole. By employing a simple adaptor at the end of the cable, it is an easy matter to connect the aluminum cable to the existing Mole. Although it is possible to manufacture Mole socket outlets made from aluminum, seizing of the threads prevents the proper operation of the cone and socket assembly.

In order to evaluate the quality of the adaptor joints, assemblies of these installations were subjected to the heat cycle test referred to previously. This test consisted of heating the combined joints by passing current so as to elevate their operating temperatures up to 390 F. The heating cycle consisted of a three hour on period and a three hour off period. This particular test was extended for 43 cycles which represents a most severe type of condition. This is especially true, considering that these temperatures can only be attained under very special faults and that these faults will probably not occur more than 5 to 6 times during the life of the conductor.



Heat cycle test on 350 MCM aluminum adaptor joint showed no overall resistance increase of joint. (Note: 1 cycle equals 3 hr on, 3 hr off.)

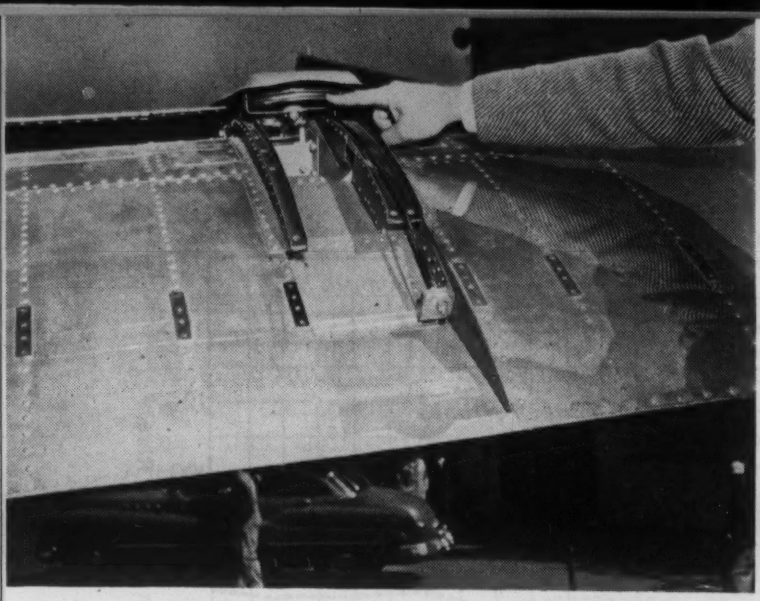
The result of this test, which was performed on 350 MCM all-aluminum cable, can be seen in the accompanying graph. Note that after the 43 cycles, the overall resistance of the joint did not increase and that in two of the samples a drop in the resistance has taken place.

The adaptability of aluminum conductors to copper has been accomplished without changing the general installation procedure. The only precaution which must be taken is to employ connectors properly designed for the conductor and the operating condition.

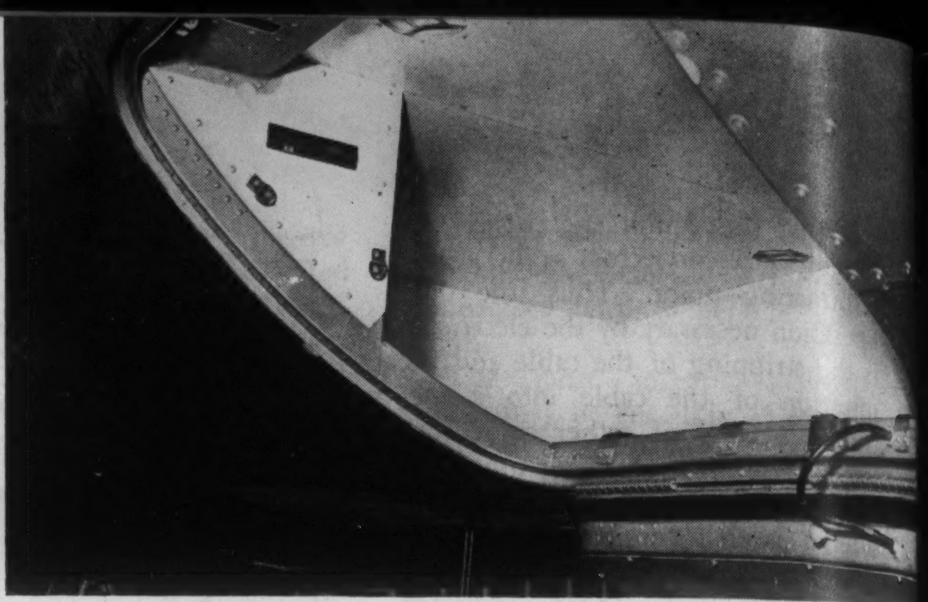
Specifications and Approvals

The connector designer and manufacturer is faced with a number of specifications and test procedures. Many customers purchase their fittings in accordance with these specifications. However, these specifications were written around copper cable. Underwriters Laboratories has established a new test procedure applicable to aluminum cable which only now is being formulated into some concrete requirements, so that the manufacturers in the future will be able to design their fittings to perform in accordance with the specifications presented to them.

The limited number of connectors at present approved by various agencies has restricted the use of aluminum cable to some degree. However, this is gradually being overcome as more and more connectors are being tested and approved or listed by these agencies.

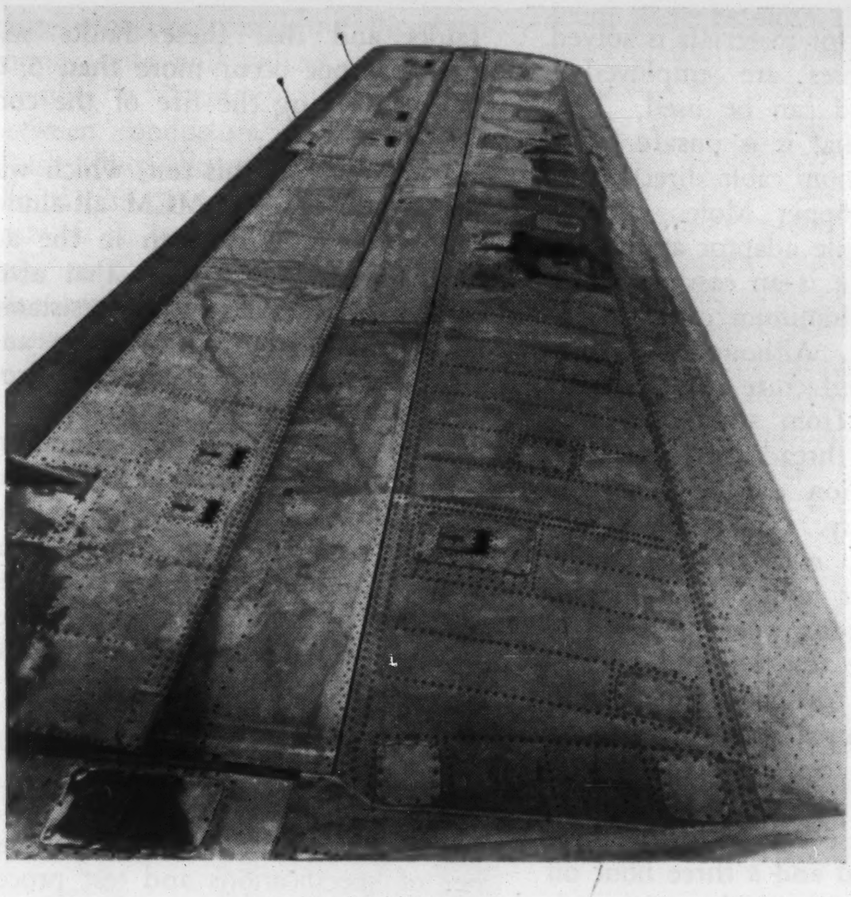


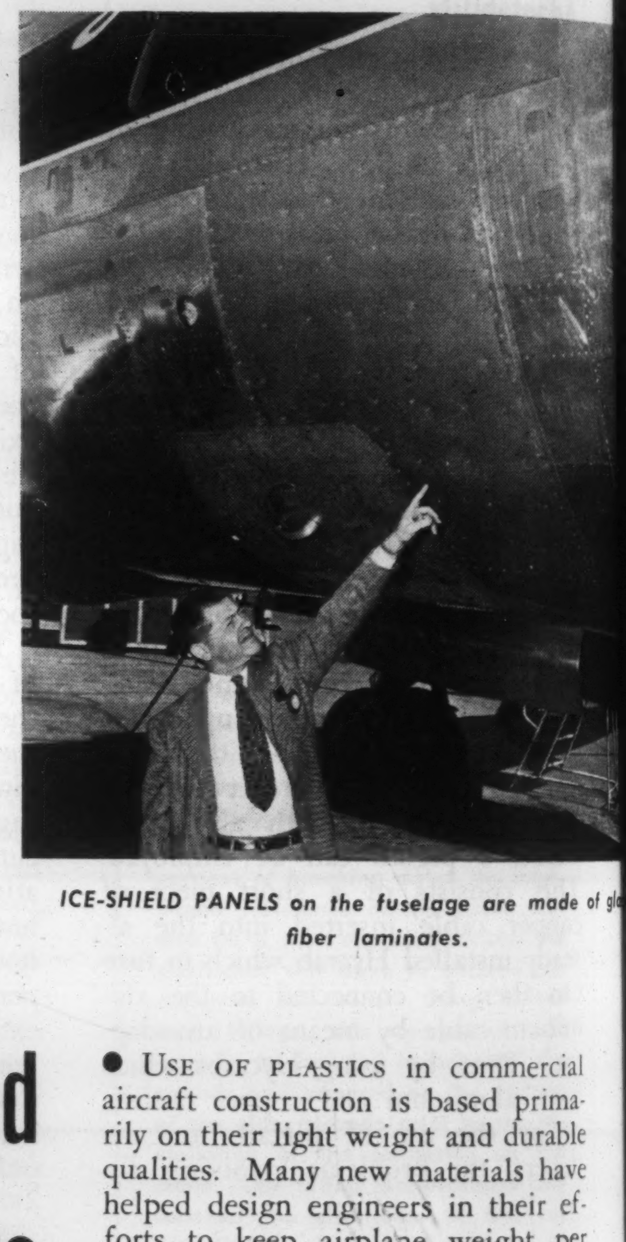
CONTROL PULLEYS which guide steel cables to ailerons, rudder and elevators are an important application of laminated phenolics.



CARGO COMPARTMENT top and sides are polyester lined.

STABILIZER'S TWO CENTER PANELS are constructed of aluminum honeycomb sandwich material bonded with a phenolic adhesive.





ICE-SHIELD PANELS on the fuselage are made of gl
fiber laminates.

Where Plastics Are Used in Air Liners

One thousand pounds of plastics are used in the 44-passenger Convair-Liner. Careful materials selection takes advantage of the properties of a variety of laminated plastics and thermoplastic resins.

by **HAROLD H. ROSENBAUM,** Plastics Engineer, Consolidated Vultee Aircraft Corp.

● USE OF PLASTICS in commercial aircraft construction is based primarily on their light weight and durable qualities. Many new materials have helped design engineers in their efforts to keep airplane weight per horsepower as low as possible. Plastics have also had a favorable effect on maintenance costs.

Since the company was organized, Convair design specialists have sought new materials to improve overall performance and to lower operating costs of aircraft. The 44-passenger Convair-Liner 340, now in production, includes approximately

1000 lb of plastics parts and furnishings. Empty weight is 28,500 lb, so that plastics constitute about 3.5% of the plane's weight.

The parts and components which cover the internal structure of the 340 include such items as seats, baggage racks, flashlight holders, lavatories, buffets, partitions, stowage bins, and instrument panels. A few of these items, however, are not made entirely of plastics. Plastics parts form a major portion of the heating and ventilating system of the airplane, and are used extensively in the electrical and radio system. Other plastics parts are on the exterior of the airplane. These items consist of wing trailing edge strips, flap rubbing strips, propeller ice shields, and antenna masts.

Thermoplastics

Thermoplastic materials used are 1) copolymer of butadiene acrylonitrile and styrene acrylonitrile; 2) cellulose acetate butyriate; 3) polymethyl methacrylate; 4) polyvinyl chloride—acetate and 5) vinyl fabrics. Modified phenolics adhesives, particularly those used for sandwich constructions, have also contributed to the increased use of plastics.

The acrylonitrile copolymer was selected for these applications because of its toughness, ability to be formed easily, color and low density. It is used both flat and in formed shapes. Such parts as wainscotting and the pilots' compartment overhead trim are made from flat sheet stock. Window frames, stowage bins, control pedestal covers, instrument consoles, and many other parts are fabricated from formed and drawn material. Approximately 225 lb are employed in each Convair-Liner.

Cellulose acetate buytrate is used for window curtain tracks, door and panel edgings, fabric retainer moldings, and panel retainers. This material was selected because of its dimensional stability and its ability to be matched to almost any desired color and approximately 25 lb is applied in this service. Methyl methacrylate serves as an inner liner for the windows to prevent moisture condensation on the surface of the glass. The material is 0.1 in. thick and approximately 16 lb are needed.

Polyvinyl chloride-acetate is applied in the form of extruded flexible tubing of various sizes. Approximately 10 lb are used principally to encase bundles of wire, serving as conduits. A large portion of the interior of the airplane is upholstered with various vinyl fabrics. These are chosen for their appearance, wear resistance, and ability to be color matched. About 142 sq yd weighing 150 lb are used.

About 10 lb of other thermoplastics, such as nylon, polyethylene and polystyrene serve in small quantities for water lines, door seals, control handles, knobs, and electrical equipment.

Laminated Plastics

Practically all of the thermosetting materials are laminated. Fiber glass fabrics with polyester or modified phenolic resins make up the bulk of the materials. Cotton fabric-phenolic laminates are used in small quantities.

The Convair-Liner has many partitions, doors, bulkheads, and overhead hat racks. These structures are composed of a low density core on which glass fiber laminate skins are bonded. The hat rack panels have a cellular cellulose acetate core, the other partitions and doors have aluminum honeycomb cores. Glass fiber laminates made with a modified phenolic resin were selected for the sandwich skins because of their superior impact resistance. For an equivalent weight, such skins can be made one third thicker than metal skins. This extra thickness gives additional ding and dent resistance which is so important for this application. Approximately 800 sq ft of laminated skins weighing about 145 lb are needed. The same type of laminate is installed as a liner for the luggage compartment. Approximately 32 sq ft of laminate weigh about 10 lb.

In the three cargo areas, a polyester resin fiber glass laminate is used for liners which are made by the continuous process, and vary between 0.025 and 0.032 in. thick. Approximately 310 sq ft of this material are required weighing 84.5 lb. About 25 lb of other polyester laminate parts including battery containers, wing trailing edge strips, power distribution box, and an oil drip pan are used also.

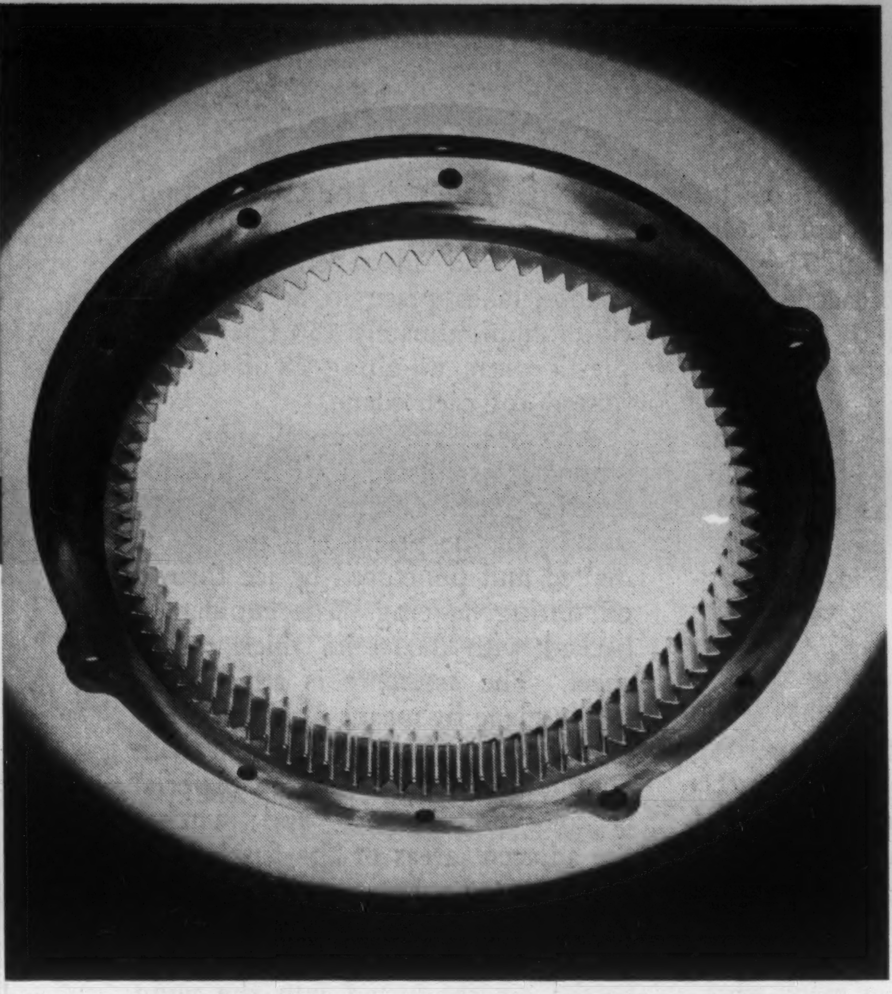
Extensive application of laminates is made in the air conditioning and ventilating system of the airplane. These laminates were chosen for their toughness and ability to be shaped to odd contours. In many instances the plastics ducts are cheaper to fabricate and lighter in weight than metal ducts. The cross sections of the ducts vary from round to rectangular and in several cases the change takes place in a single section. Approximately 150 lineal ft of plastic ducts weighing 28 lb are required for each plane.

An interesting application of laminates is a shield to protect the exterior metal fuselage skins in the vicinity of the propellers from being dented and punctured by ice thrown off during de-icing. The laminate is backed with 0.016 in. thick rubber sheet. The assembly is attached to the fuselage by means of screws. The laminating resin is pigmented with aluminum so that the cured material is color impregnated and matches the adjacent areas of the fuselage.

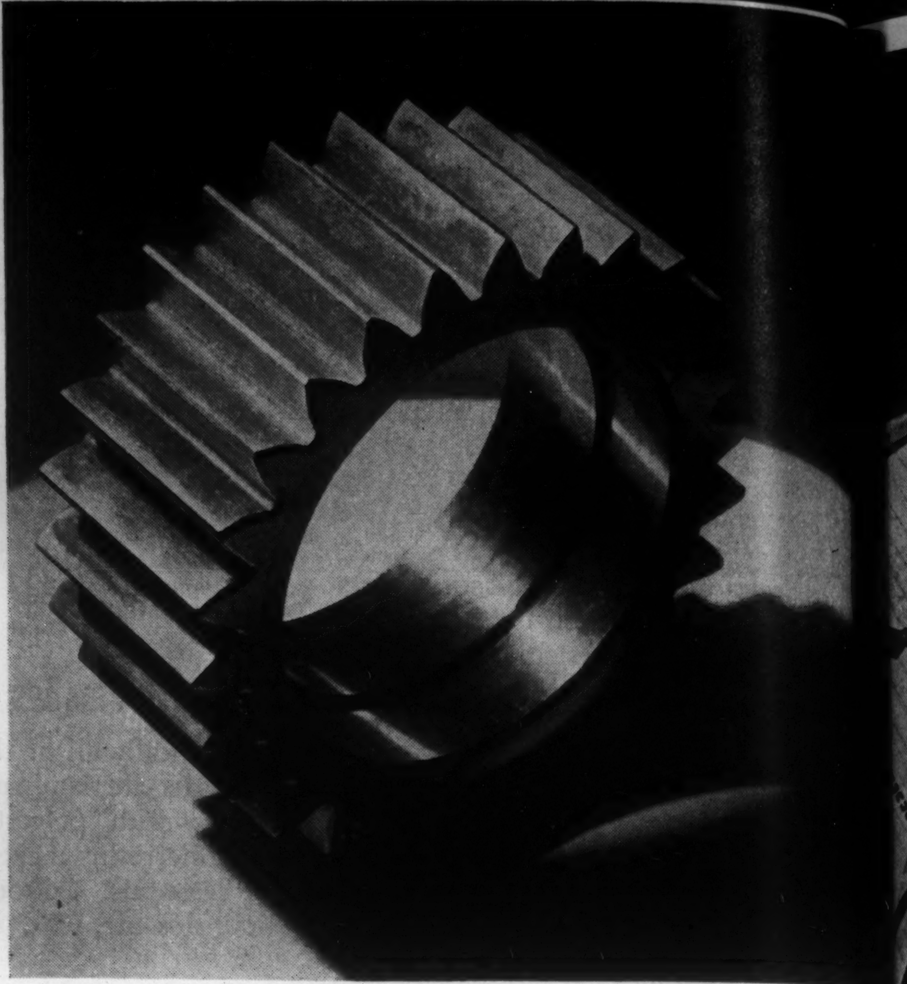
Laminated plastics are used also for liners in the leading edge of the wing. The material helps confine the heated air conducted into the wing for anti-icing. Temperatures in the neighborhood of 450 F are employed and the material must not soften or become limp. A special high temperature resisting phenolic resin is required for these laminates and approximately 100 sq ft weighing 10 lb are used in each wing.

Relatively small amounts of cotton base post-formed phenolic laminates are used chiefly for the 22 air diffusers located in the assembly under the hat racks. The diffusers contain the fresh air regulators above the seats. Other post-formed laminate parts are radio rack covers, plenum pans, and pilots' floor scuff plates. About 9.5 lb are used per airplane. An important application of laminated phenolics is in control pulleys. These pulleys guide steel cables to the ailerons, rudder, and elevators. About 105 laminated standard AN pulleys are required per airplane, with diameters varying from 1.25 to 5.5 in. Their combined weight is approximately 14 lb.

All the flooring is of sandwich construction. The core is aluminum honeycomb and the skins are aluminum alloy sheets bonded to the core by means of modified phenolic adhesive. The luggage racks and radio equipment racks are constructed in the same manner. About 600 sq ft of metal sandwich and 400 sq ft of the fiber glass sandwich mentioned previously utilize 110 lb of resin adhesive in each airplane. It is estimated that about 25 lb of various types of molded and laminated plastics are used in radio and electrical equipment.



Internal ring gear
I.D. 9.937 in. +0.010 —0.000
O.D. 10.936 in. +0.000 —0.001
Flange dia 13 3/16 in. ± 1/16
Teeth carburized to a depth of 0.030 to 0.040 in.
Case hardness Rockwell C 60 to 64
Core hardness Rockwell C 36 to 40



Pinion gear
O.D. 3.5625 in. +0.0000 —0.0030
I.D. 2.4421 in. +0.0000 —0.0008
Teeth carburized to a depth of 0.030 to 0.040 in.
I.D. carburized to a depth of 0.050 to 0.070 in.
Case hardness Rockwell C 60 to 64
Core hardness Rockwell C 36 to 40

Heat Treating Gears

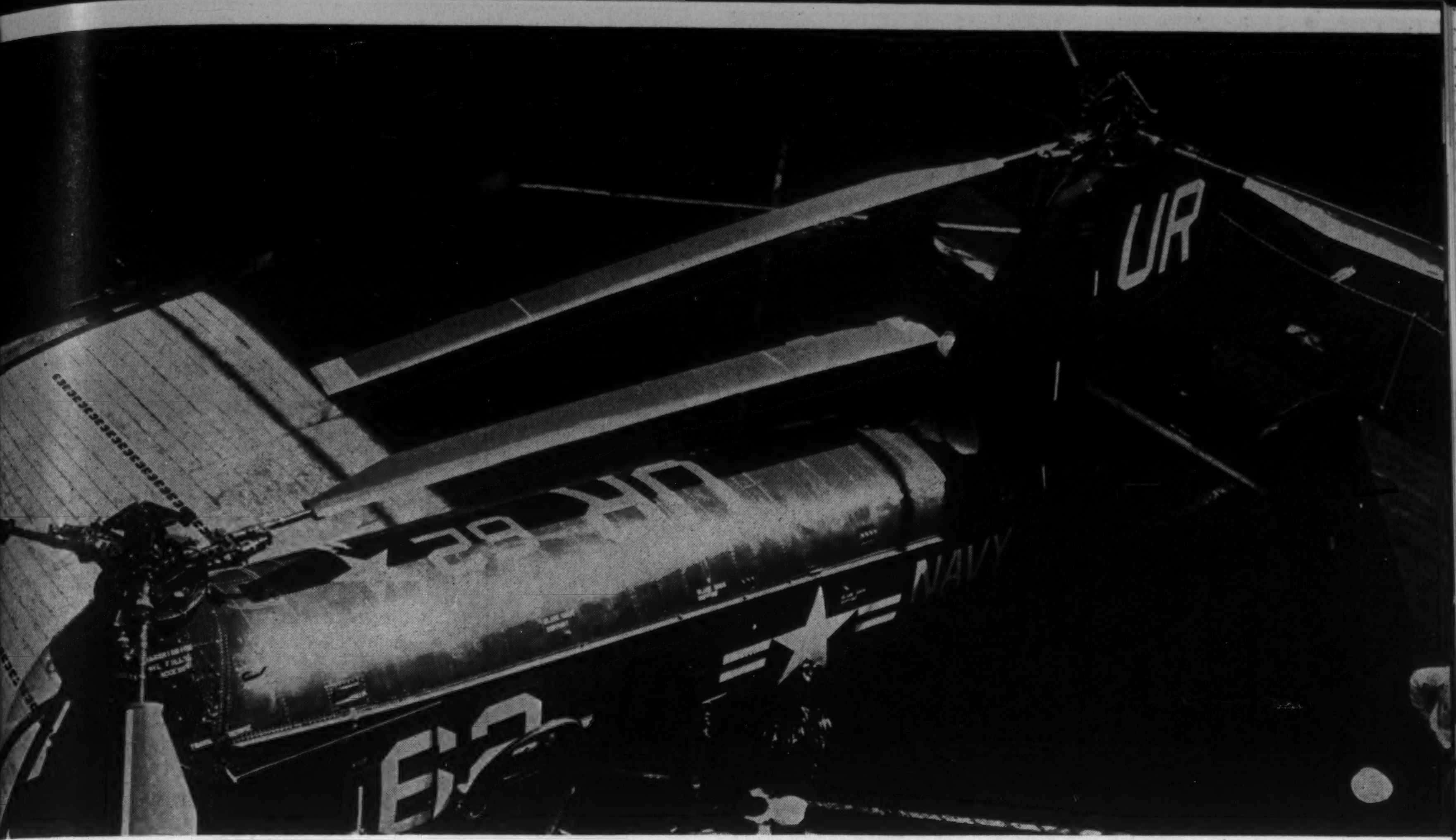
Careful control of carburizing and subsequent heat treatment yields gears with optimum case and core properties.

● HELICOPTER transmission gears must support the entire weight of the airplane when it is airborne without failure. They are also designed to meet a maximum strength to weight ratio. To function satisfactorily, these gears must have a hard case supported by a tough core and a metallurgical structure which will have optimum properties. Thus, heat treating procedures must be closely controlled to obtain an end product which will meet the rigid requirements of the design from the standpoint of maximum wear resistance and strength.

The transmission gears must be made from forged stock. The gear blanks are hammer forged between 2200 and 2250 F, using dies to obtain optimum grain flow in those areas that are to withstand severe service stresses. The material is electric furnace, aircraft quality steel, AMS 6260 (AISI 9310) as the preference, and AMS 6252 (AISI 3310) as the alternate. After forging, the parts are normalized to relieve forging stresses and to homogenize the structure to eliminate ferrite banding. After normalizing, the forgings are rough machined to remove excess stock. Then the blanks are stress relieved to minimize distortion that can occur in the subsequent carburizing operation. Since it is sometimes necessary to do some machining after carburizing, if distortion is minimized by stress relieving, equal amounts of stock can be removed without setting up new stresses. After stress relieving, the parts are semi-finished machined which includes cutting the gear teeth. Parts are then prepared for carburizing.

Since the gear is selectively hardened, certain areas are not carburized. To prevent carburization of these areas, a copper plate of 0.001 in. to 0.0015 in. thickness is applied. Areas such as gear teeth, and bearing surfaces which are to be hardened, are not copper plated. After plating, the parts are degreased and cleaned, so that no oil remains on the parts to contaminate the carburizing atmoshere.

All parts are carburized at 1700 F for sufficient time to produce a case depth that will fall within the requirements of the finished ground part. Carburizing is done in Leeds & Northrup Homocarb furnaces using their Homocarb fluid as the source of carbon supply. The hypereutectoid zone of the case is maintained at about 0.90% carbon and is controlled by the use of the Leeds & Northrup Microcarb attachment. With this control, the optimum carbon content can be obtained and no diffusion cycles are necessary. On furnaces without this control, diffusion cycles are employed at the end of the carburizing cycle to bring the carbon content of the case to the desired level.



Vital to the satisfactory functioning of the helicopter are the gears which transmit power to the rotors (Piesecki).

to Meet Rigid Requirements

by RALPH SPAGNOLA, **Metallurgist, Ford Instrument Co., Div. of the Sperry Corp.**

As a check of the Microcarb control, and of the diffusion cycle, the carbon content of the case is verified by chemical analysis of a sample carburized with the parts. As an added check on the uniformity of the carburizing process, three samples of the same type of steel as the parts are placed in the load at the top, middle and bottom of the charge.

After carburizing, parts are removed from the furnace and transferred to a cooling pit where they are allowed to slow cool to a temperature low enough for handling. Samples carburized with the parts are sectioned, polished, etched, and examined under the microscope. Case depth and character of case are noted, and a permanent record is kept of each heat carburized. The parts are sandblasted to remove loose scale that has formed during slow-cooling from the carburizing temperature. The copper plate is stripped off, parts are cleaned, and replated with flash copper for the hardening operation.

Parts are reheated for hardening in a Westinghouse electrically-heated atmosphere-controlled furnace using Endogas as the atmosphere. All gears are oil-quenched from the range 1500 to 1525 F using expanding-type dies or fixed sized plugs depending on the design of the part. A No. 26 Gleason quenching press is used with the expanding-type dies. Distortion is held to a minimum and is uniform so that equal amounts of stock are removed during subsequent grinding operations.

The minimum hardness after quenching is Rockwell C63 in the carburized areas, thus assuring a minimum amount of retained austenite in these areas. Core hardness is held between Rockwell C36 and 40. Parts are held round to within a maximum of 0.003 in. and flat to within a maximum of 0.002 in. during quenching. After hardening, the parts are tempered at 300 F for four hours. Hardness after tempering is Rockwell C60-64 for carburized areas and Rockwell C36 to 40 for the uncarburized areas. After tempering, the parts are re-inspected for size and hardness, copper stripped. and routed to the next operation.

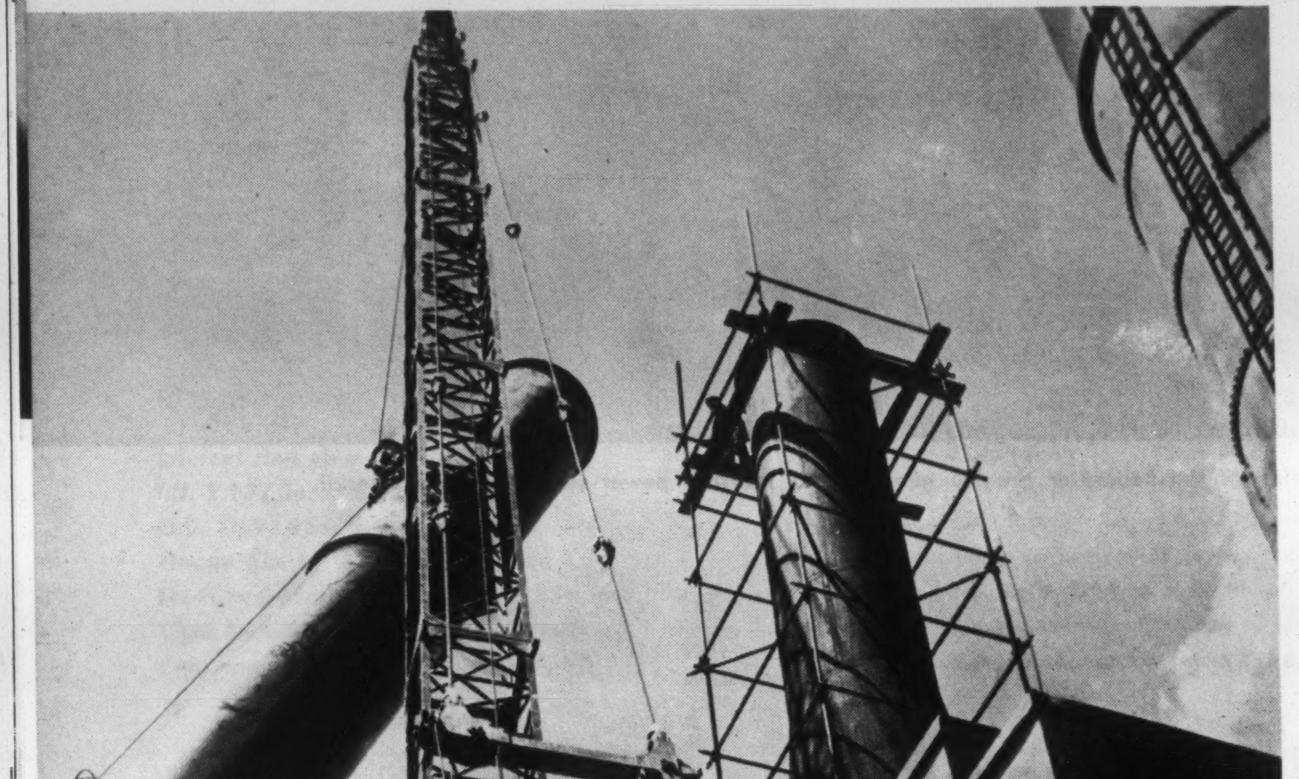
Control of carbon content of the case during carburizing results in a metallurgical structure consisting of a fine grained tempered martensitic matrix with a uniform dispersion of fine hard wear-resisting carbides, and very small amounts of retained austenite in the finished part. No network carbides exist to promote the possibility of cracks developing during the subsequent grinding operations. Quenching from a minimum temperature of 1500 F assures the absence of free ferrite in the core. Thus a hard case supported by a tough core is obtained.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .



GLASS-LINED SMOKE STACK

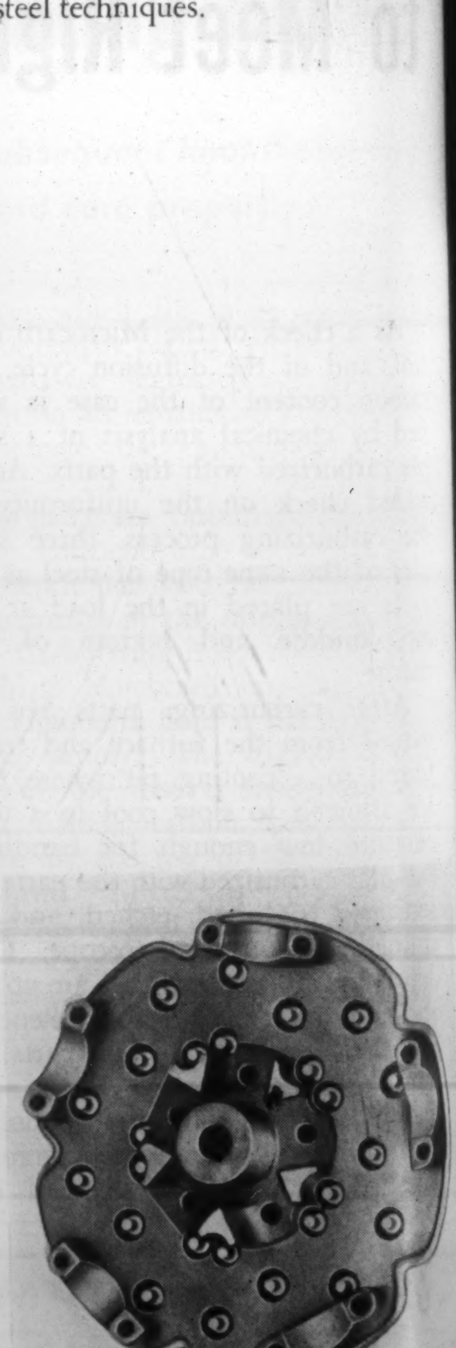
Three-ton section of glass-lined smoke stack 44 ft in length and six ft in dia, being hoisted aloft by a 120-ft boom crane to form the top section of an 85-ft power house stack at the Milwaukee plant of the A. O. Smith Corp.

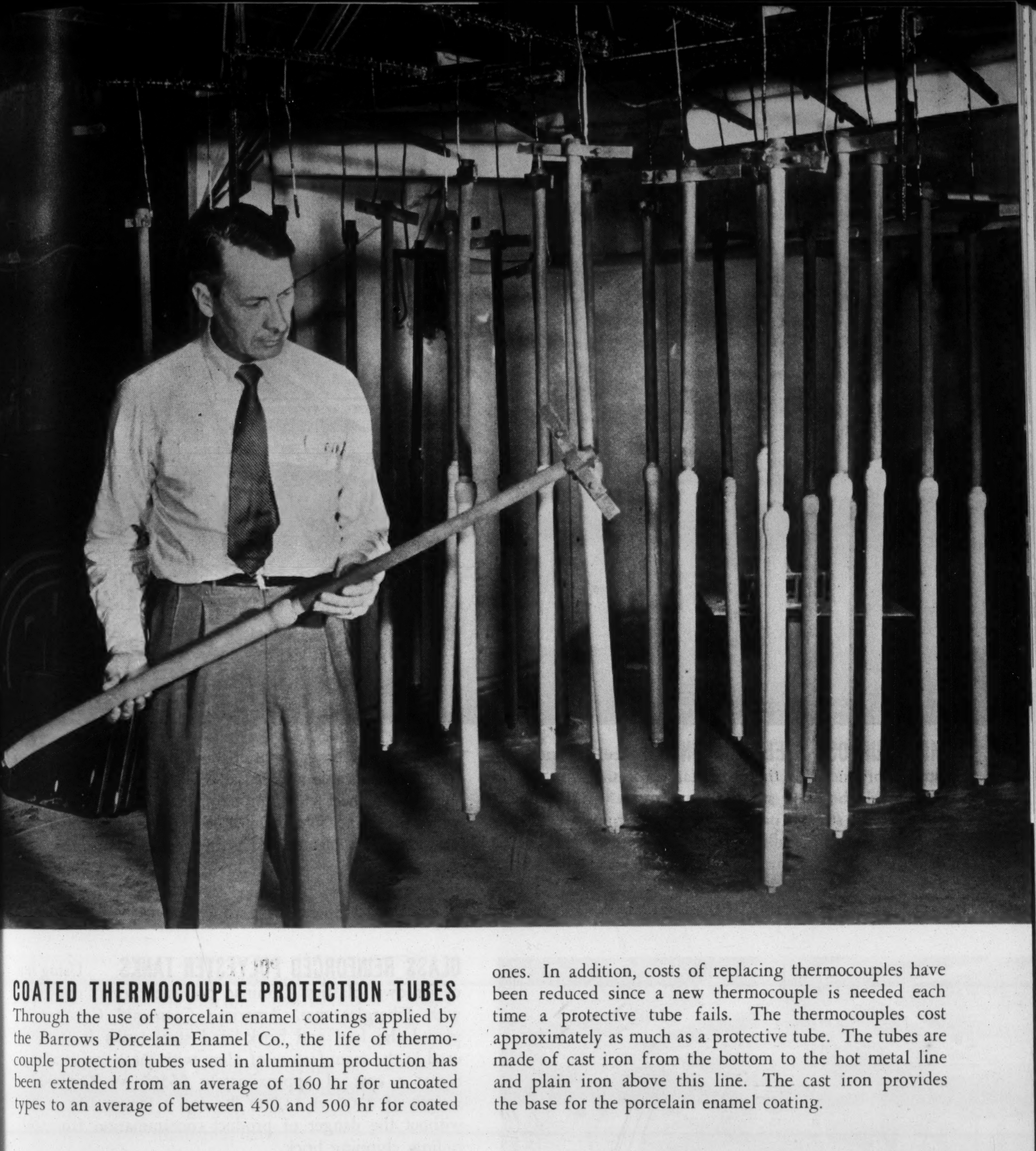
The stack section is coated inside and out with two linings of special acid resisting glass, each approximating five one-thousandths of an inch in thickness.

This glass-lined stack will be kept under observation for the next few years. If tests prove satisfactory, A. O. Smith expects to find in the process of glass-lining stacks a new commercial adaptation of its glass-fused-to-steel techniques.

RF TUNER PLATE MADE OF GLASS-BONDED MICA This high frequency contact plate provides precision tuning of five RF channels. Although the circuits tuned operate at high frequency, permanently accurate tuning is attained.

The part described is produced by Mycalex Corp. of America by injection-molding Mycalex 410 glass-bonded mica dielectric, which is molded to close tolerances and incorporates a series of coin silver contacts, stainless steel distributing rings, and an integral center hub. The use of Mycalex insulation results in low dielectric loss, long-term dimensional stability, and permits precision molding with resultant dimensional uniformity of all pieces.





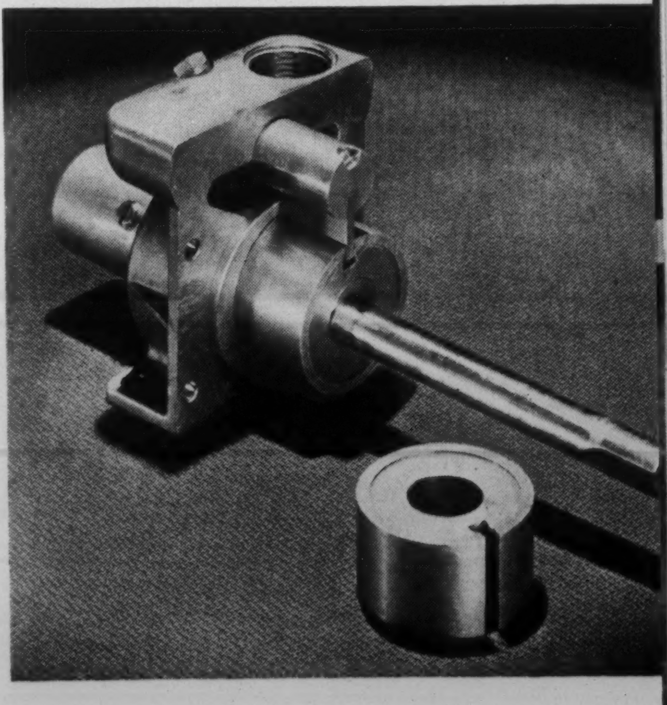
COATED THERMOCOUPLE PROTECTION TUBES

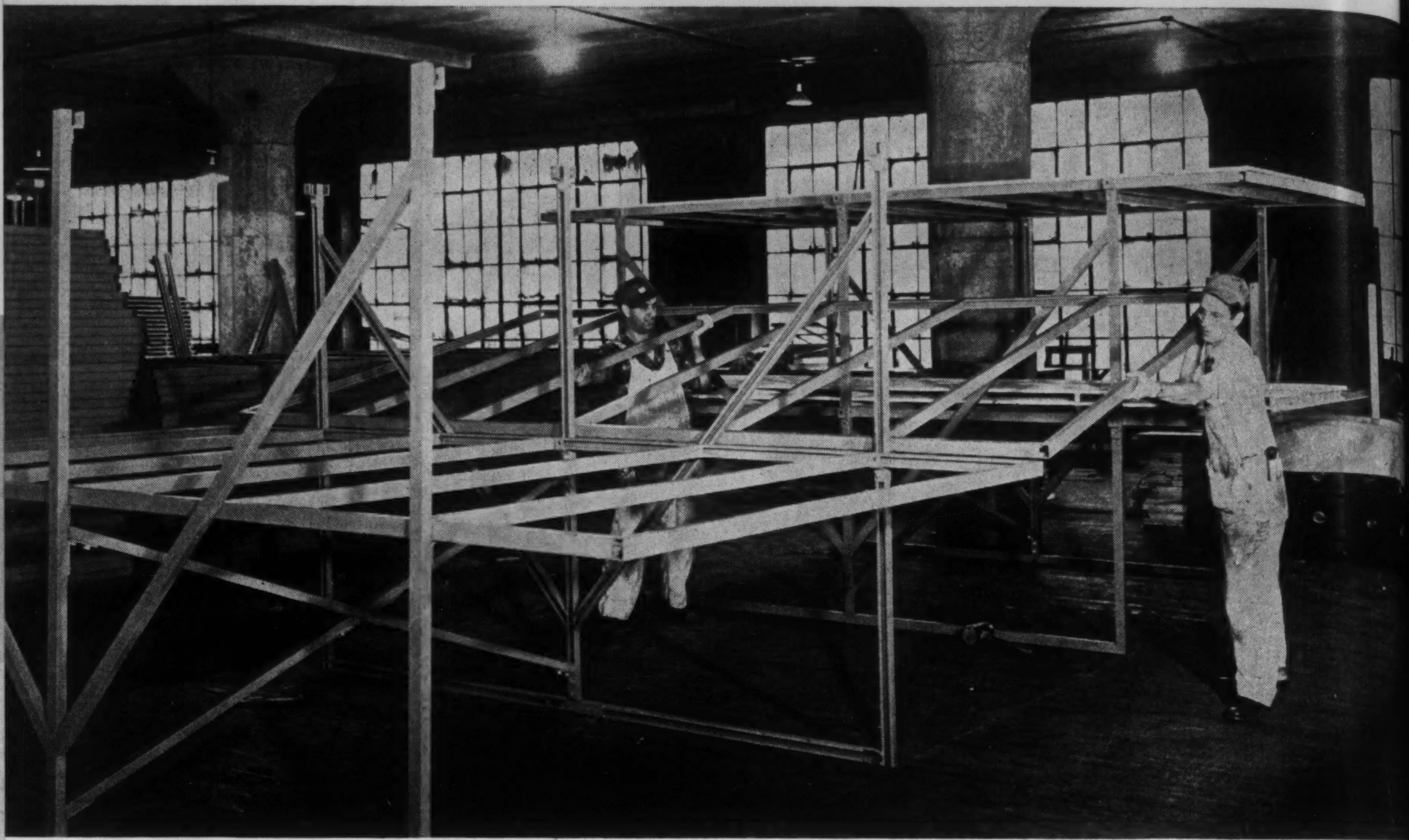
Through the use of porcelain enamel coatings applied by the Barrows Porcelain Enamel Co., the life of thermocouple protection tubes used in aluminum production has been extended from an average of 160 hr for uncoated types to an average of between 450 and 500 hr for coated ones. In addition, costs of replacing thermocouples have been reduced since a new thermocouple is needed each time a protective tube fails. The thermocouples cost approximately as much as a protective tube. The tubes are made of cast iron from the bottom to the hot metal line and plain iron above this line. The cast iron provides the base for the porcelain enamel coating.

METAL POWDER PUMP FOR LUBRICATING FLUIDS

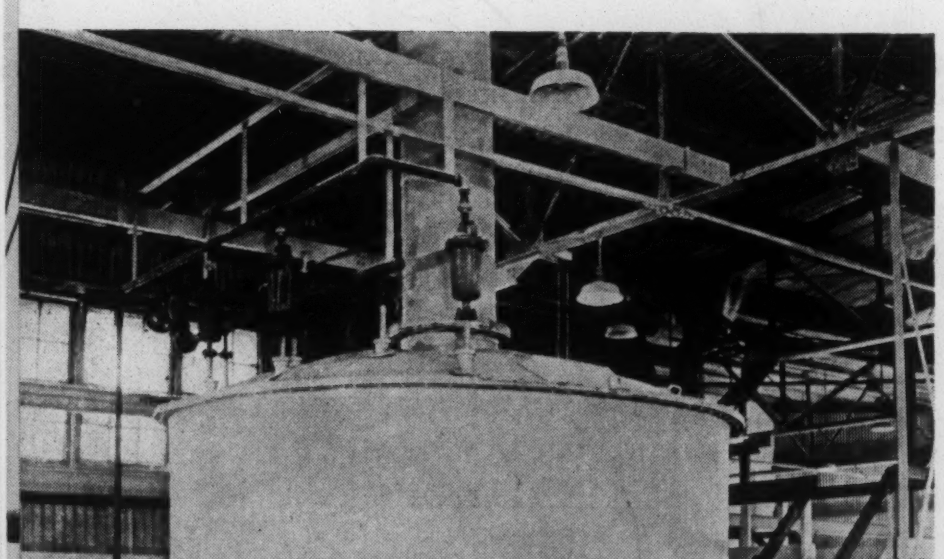
Following two years of field tests covering a wide temperature and viscosity range of clear lubricating fluids, Eco Engineering Co. has offered a bronze-impeller, positive-displacement pump for the handling of oils and greases.

The outstanding advantages of these pumps are: (1) their positive displacement delivery, the result of two axially oscillating impellers which deliver continuous, non-surging flow without foaming or air entrainment; (2) their precision machined and sintered bronze powder-metal impellers, which act like oiless bearings operating in a lubricating medium in that they absorb oils like a sponge and retain them, greatly minimizing the dangers of heat seizures and scorched impellers. These pumps are self-priming in low temperatures. Their operation, characteristic of their design, provides high efficiency with less horse power and with smaller, lower cost motors. Eco-Bronze Impeller Pumps are suitable for operating oil temperatures up to 500 F. Their suction lift compares favorably with the best obtainable with other types of positive-displacement pumps. They can be operated submerged. They will pump in either direction and in any position.





MULTIPURPOSE STEEL FRAMING Steel channels and fittings produced by the American Steel and Iron Works are used in building support framing on the job. Racks for material storage pallets, skids and drums are quickly assembled to fit individual needs. Other applications include stands for machinery and electrical equipment. substation framing, partitions and pipe supports. Storage is fully adjustable and reusable, and racks can be altered quickly to meet changing requirements. Available also with the same interchangeable features are roller pipe supports, pipe clamps and fittings for fluorescent lighting fixtures.



GLASS REINFORCED POLYESTER TANKS Using one of its own plastics, Laminac polyester resin, reinforced with Fiberglas mat, American Cyanamid Co. has replaced the lead and brick-lined steel tanks it formerly used in the manufacture of alum with these major advantages: a cost of approximately \$6500 vs \$14,000; a weight of 2200 vs 13,200 lb; and a longer life in use, without the danger of product contamination from corroding, chipping brick.

The tanks serve to evaporate to dryness an aluminum sulfate liquor whose pH of 3 makes it a very corrosive agent. The process, carried out at temperatures that range from 160 to 242 F, takes approximately 4 hr. The charge for each cycle is 4000 gal, which weigh 20 tons. The high strength-weight ratio of the reinforced plastic made it possible to build the tank with a side-wall thickness of only 3/8 in., and a bottom thickness of only 1/2 in. The tanks are 8 ft high, 14 1/2 ft in dia, and are equipped with stacks (also fabricated from reinforced plastic that are 22 ft high and 30 in. in dia).

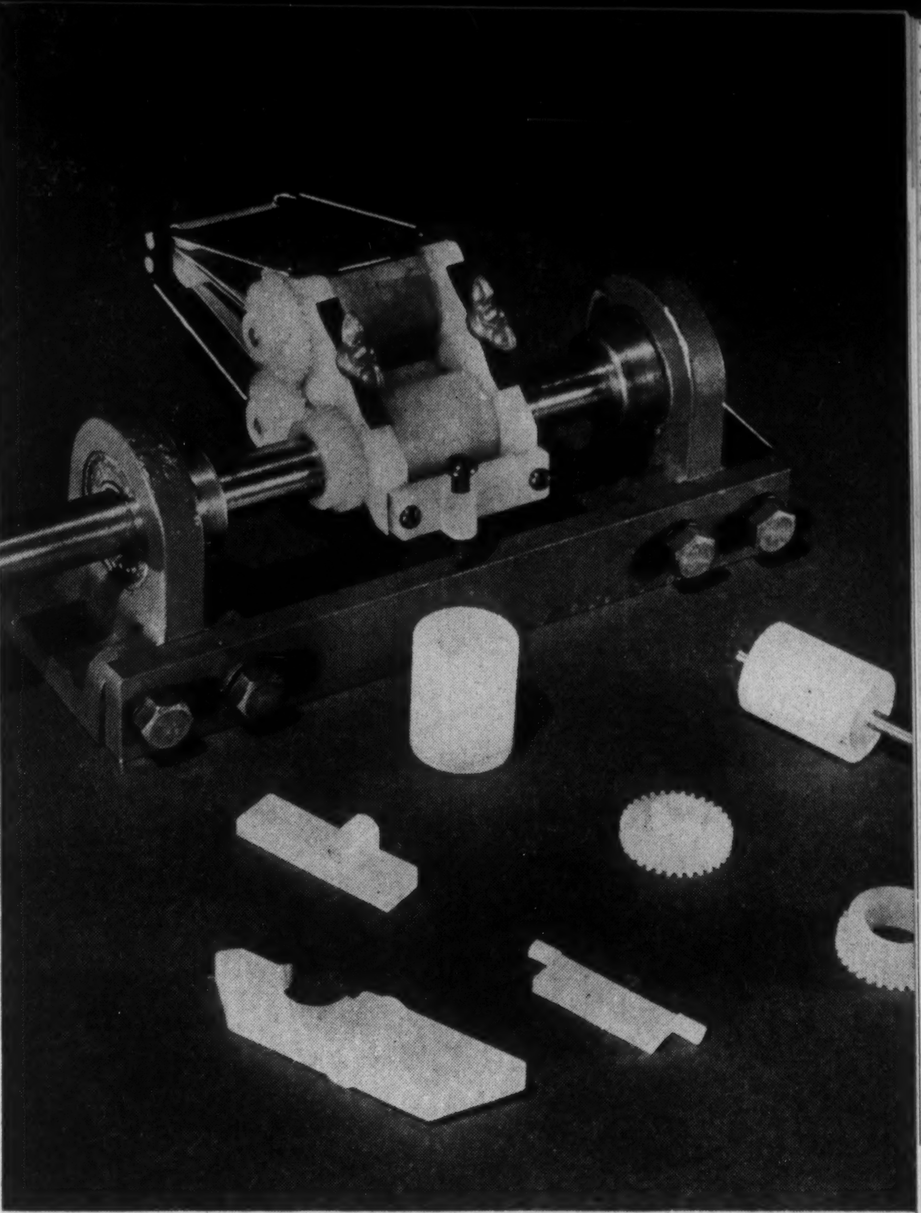
The one-piece molded tank was fabricated for Cyanamid by Carl N. Beetle Plastics Corp., using the firm's Laminac Resin 4119, the type which has shown the best chemical resistance in this family of plastics.

MOLDED NYLON GEARS, BEARINGS IN LONG-DRAFT SPINNING UNITS

Full-scale production of long-draft spinning units in which gears and bearings are made of molded du Pont nylon has been undertaken by Macdonald and Sons, Inc.

A major advantage is the resilience of nylon gears, which permits individual units to be removed and replaced in a matter of seconds without stopping the spinning machine. Since the average machine incorporates 200 to 400 of these long-draft units, the savings in down-time are expected to be considerable. From 12,000 to 300,000 long-draft spinning units are used in the average textile mill.

Performance during trial installations indicates that nylon in these units will outwear previously used materials. Other benefits gained by the use of nylon include reduced power requirements, attributable to nylon's low coefficient of friction and to the fact that the newly designed units weigh only about 25% of those which they replace. The dangers of yarn contamination by oil or metal splinters are also eliminated since the nylon parts in this application require no lubrication.



SINTERED NYLON BEARINGS

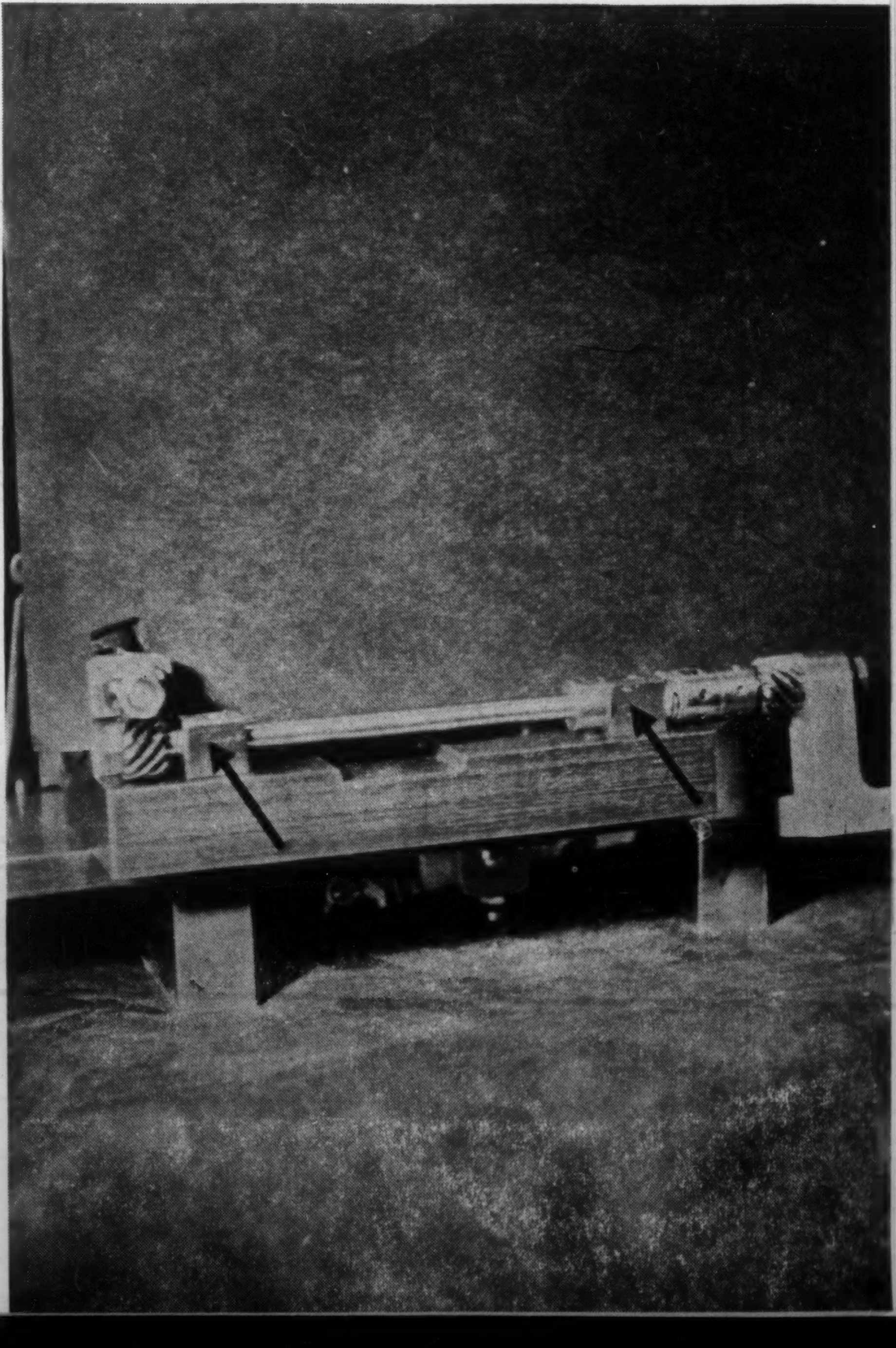
Low friction sintered nylon has demonstrated its value as a bearing material by withstanding 18 months of continuous use in light production machinery without visible evidence of wear and without lubrication.

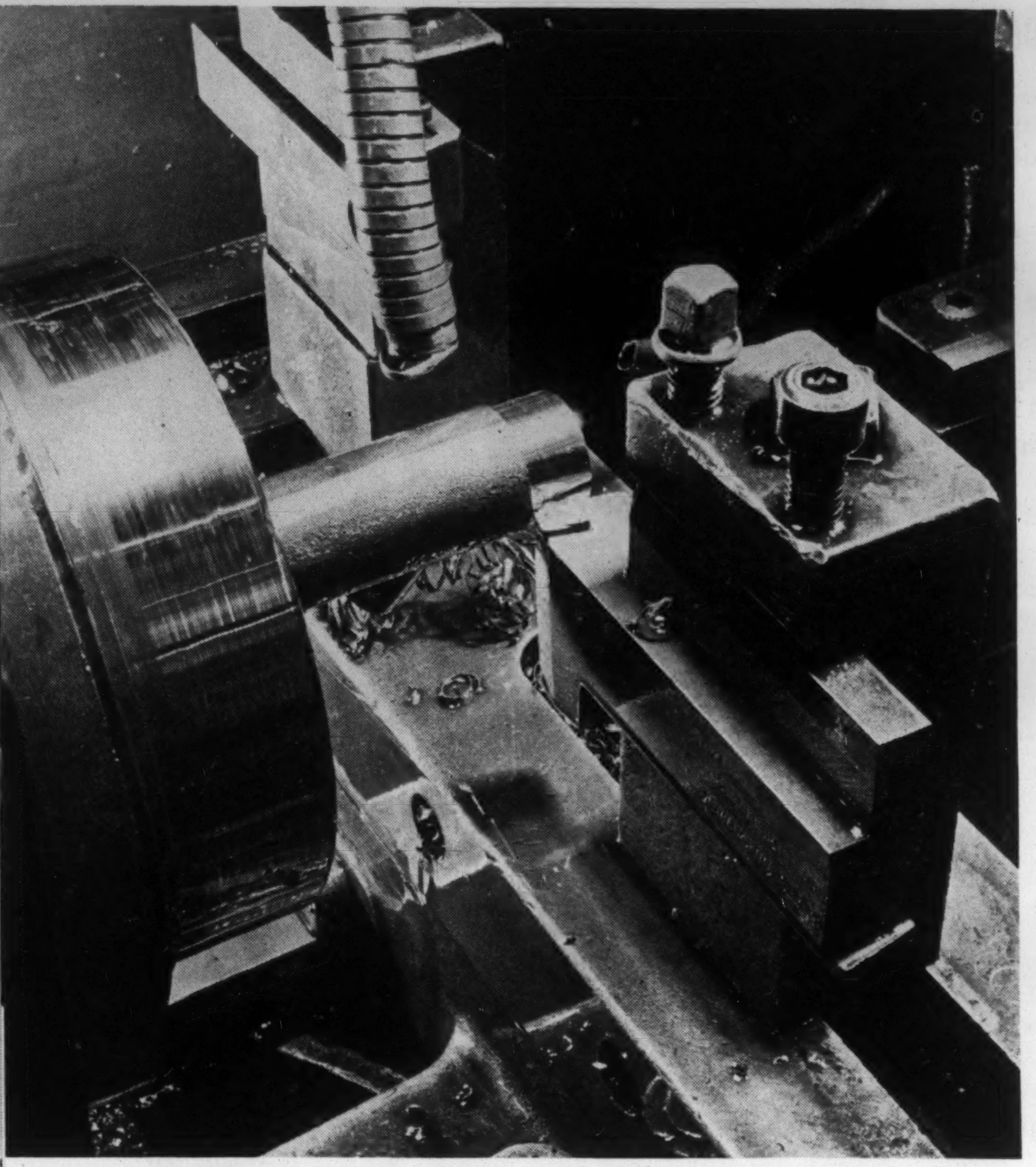
Six sintered nylon bearings were installed in place of bronze bearings on the conveyor belt roll feed and horizontal back shaft of a machine used by Ace Art Co. to make corners for mounting photographs, cards, etc. Except for a few "break-in" drops of oil at the time of installation, the nylon bearings required no lubrication. The machine, according to company reports, has been in steady operation 8 hr a day and 5 days a week since Oct. 3, 1951, the installation date.

All the sintered nylon bearings in this application were made from Nylasint Molding Powder—Type 66, a finely divided nylon powder supplied by National Polymer Products, Inc.

The powder used in making the nylon bearings is produced by a chemical process that makes the material suitable for cold pressing and sintering. It lends itself readily to the production of sintered nylon bearings, gears, cam rollers, valve seats and other industrial products.

Laboratory and field tests indicate that bearings made by cold pressing and sintering nylon powder have an unusually low coefficient of friction and show great promise for use in frictional applications where operation without lubrication is required.





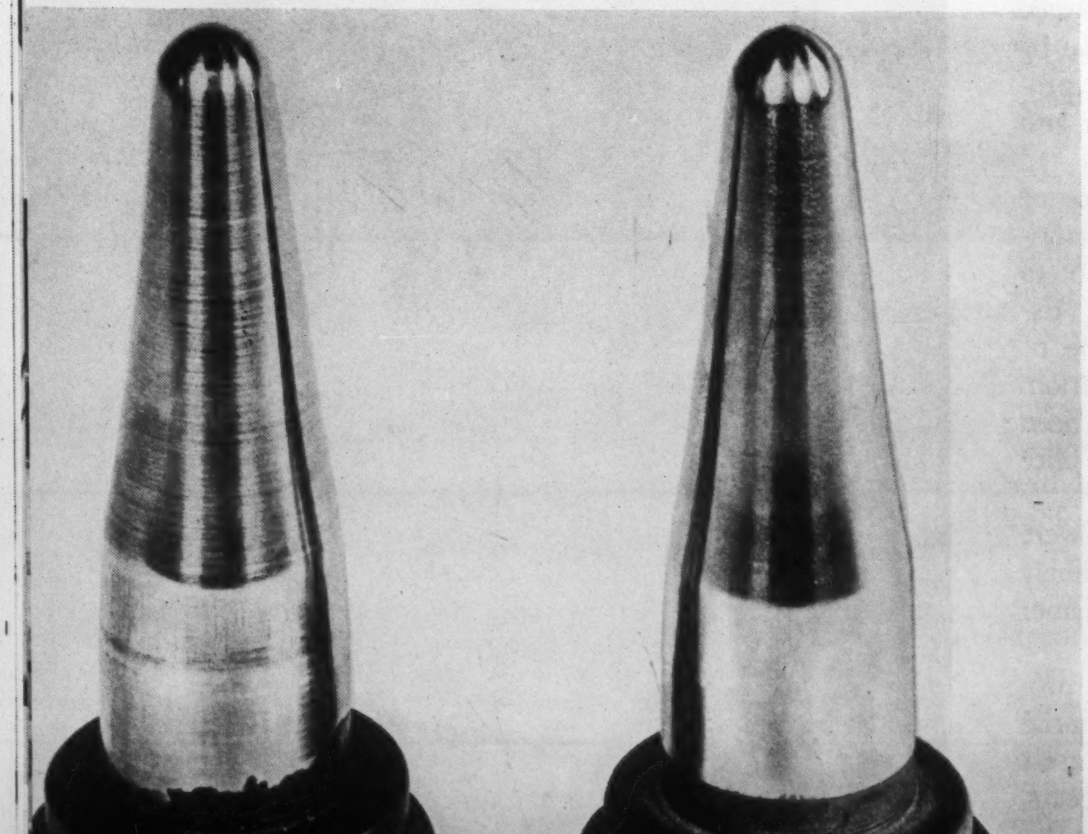
SQUARE CARBIDE INSERTS REDUCE MACHINING COSTS ON STAINLESS STEEL FORGINGS

Direct tool cost savings of approximately seven dollars per thousand parts produced, plus additional savings resulting from minimized tool changing and grinding time, were recently secured at a prominent Midwestern manufacturer's plant by using indexable square carbide inserts for rough turning forged 321 stainless steel jet engine nozzles—at 1/20 of previous tool cost.

Using Kennametal tungsten carbide square insert tools of style SBR-85 in grade K6, 325 to 350 pieces are turned per cutting edge at a feed of 0.003 in. per revolution. Depth of cut is 0.093 in. at 1480 revolutions or 490 surface ft per min. Lathe used in the operation is a No. 3 Warner and Swasey of 10 h.p. With four cutting edges available on each end of the clamped insert, an average of 2700 pieces are machined between grinds. Since about 1/32 in. of stock is removed from each of the insert's ends in regrinding, estimated pieces per insert is 32,400.

In running a cost analysis on the use of the Kennametal tool, the producer found that with the tool holder being used for the life of five inserts, tool cost per piece averages about 1/28 of a cent.

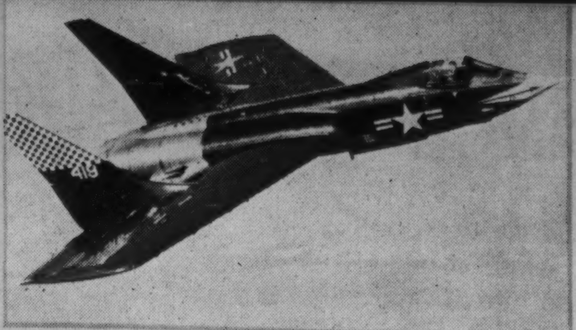
To turn 32,400 pieces with a brazed tool would have required approximately 50 tools at $4.55 each, or a total tool cost of $227.50 or 0.7¢ per piece produced.



HARD-FACED PLUNGERS Metal plungers for molten glass, protected from heat and wear by Colmonoy spray-welded chromium-nickel boride hard-facing alloy surfaces, are functioning up to 54 times longer than conventional cast iron plungers.

The hard-facing alloy is applied by a powder metal spraying unit in a process that provides a nonporous, fusion bonded, wear and heat resistant surface up to 0.060 in. thick. Much less lubrication is required for plungers, thus avoiding surface contamination in containers. The alloy surface can be renewed by respraying and re-fusing when wear occurs. Quality of the glass containers has also been improved by smoother inner surfaces resulting from the use of plungers which retain their smooth surfaces for long periods of time.

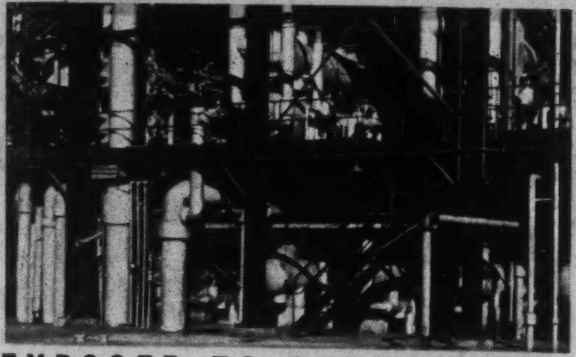
No design changes are necessary to apply the process to the hard-facing of conventional glass plungers, with the exception that mild steel instead of cast iron is specified as the plunger base material. The Colmonoy surface has high resistance to oxidation at elevated temperatures. It is claimed to have great resistance to wear and corrosion, with the ability to outwear hardened steel by from 5 to 25 times. It resists most acids and all strong alkalies. Hardness is from 56 to 61 Rockwell C scale.



WHICH COATING FOR SERVICE. . . IN ATMOSPHERE

. . . UNDERGROUND

. . . IN WATER



. . . EXPOSED TO CHEMICALS

Selecting Protective Coatings for Metals

by John B. Campbell, Associate Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 96

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

Not a conventional cataloging, but a functional guide to the proper choice for various types of service. Emphasis is on the corrosive environment to be encountered, with mechanical durability, appearance and cost also considered. Conversion, organic, metallic and vitreous coatings are discussed.

The Functional Approach to

1: Consider the Conditions

a. Environmental. What environmental conditions must be met by this product?

b. Physical. What physical conditions must be met by this product?

c. Market. What market conditions must be met by this product?

2: Set the Policy

x. Performance. What is the minimum desirable length of service and standard of performance of this product?

y. Appearance. What is the minimum desirable standard of appearance of this product?

z. Cost. What is the maximum desirable cost of this product?

3: Select the Coating

A. Which of the available protective coatings are eliminated by consideration of factors *a* and x (environmental performance)?

B. Which of the remaining available protective coatings are eliminated by factors *b* and x (physical performance)?

C. Which of the remaining available protective coatings are eliminated by consideration of factors c and z (cost)?

D. Which of the remaining available protective coatings are eliminated by consideration of factors c and y (appearance)?

E. Which of the remaining available protective coatings is the most economical?

Note: Factors A, B, C and D are interchangeable, their or der depending on the particular application.

Much has been published on the properties of the various protective coatings for metals. And much has been published on the type of finish selected for a particular metal product. What has been conspicuously lacking is an overall functional approach to the selection of protective coatings for metals which would be of practical use to a fairly broad audience.

There is some justification for such an omission. The functional approach consists of attacking a problem from the standpoint of what is

Selecting Protective Coatings

needed, instead of the unscientific method of "trying on" arbitrary solutions until one fits. Unfortunately, where the "what is needed" happens to be a certain standard of performance by a metal product, the number of factors which must be juggled becomes discouraging. The complex nature of corrosion, itself, puts a strain on the functional approach.

It would be a tedious and space-consuming task to attempt to pinpoint the proper protective coating for every conceivable set of conditions. Experience has shown that it is risky to assume that the effects of variations in environmental conditions are negligible. Yet useful generalizations can be made if they are broad enough. And even somewhat broad generalizations are much more useful than none at all.

In this article, eight general environments have been selected. In approximate order of increasing severity they are: indoor atmosphere, rural atmosphere, industrial atmosphere, marine atmosphere, soil, water, sea water and chemicals. These environments encompass the entire range for which a metal product might be intended. Each section discusses briefly the type of protective coatings which are used successfully in that type of environment. Important limiting factors are emphasized and relative costs indicated in so far as possible. Space limitations prohibit complete descriptions of the various protective coatings but further information can be obtained from the literature and from industrial suppliers and contractors.

To apply such information to a specific problem requires a functional approach by the engineer. Where corrosion resistance is of primary importance, the sequence of decisions outlined in the accompanying table is recommended.

This selection process is basically quite flexible. Questions *A, B, C* and *D* are arranged in order of importance for the specific application (*E* is always last). The order adopted above, for instance, might apply to a shipping container for a highly corrosive fluid. For a child's toy, on the other hand, the order might be reversed: *D, C, B, A.* Decision by progressive elimination is advantageous in that it tends to insure that no protective coating is discarded arbitrarily.

Policy must also be flexible. In the table for instance, all remaining protective coatings might be eliminated by *C.* This would be an indication that the standards set by policy factors *x* and *y* were too high to be practical. A change in one or both of these standards would be essential. The only alternative would be to change conditions *a, b* or *c* and this would establish an entirely new problem.

The functional approach is informative. Suppose that all protective coatings were eliminated by *B.* It is obvious that the standards have been made too rigorous. But which standards? Since only *A* and *B* have been examined, only policy factor *x,* the performance standard, is involved. This factor is the one which must be changed before any further examination.

The functional approach outlined above is nothing more than highly organized common sense. Yet it is how a product designer must think if he is to select the optimum protective coating for a specific application.

There will be no attempt in this article to pinpoint the proper protective coating for any given set of conditions. Depending on the complexity of the problem, it should be possible to narrow the choice to a limited number of coatings. For any relatively *mild* environment, past experience and a knowledge of materials may indicate one particular coating. But almost any *severe* environment is tricky and demands a reasonable amount of trial and error. For such environments, actual service testing is strongly recommended. Although corrosion data continues to accumulate and our understanding of corrosion continues to improve, it is probable that this empirical element in the selection of protective coatings will not soon be eliminated.

Nor does the selection problem end here. Each type of coating has many variations. Generally there is more than one supplier or contractor ready to provide the material or service required for the type of coating that seems to be indicated. There are two common approaches:

1. For small-scale production, try out samples of various proprietary materials or samples finished by various contractors. Select the most suitable.
2. For large-scale production, take the product, the problem and all the thinking that has gone into it to a reputable supplier or contractor and let him work out the optimum finish.

Surface Preparation

Preparation of metal surfaces for protective coatings is a subject in itself. It will not be covered in this article. But three important facts should be kept constantly in mind in connection with later discussion:

1. Good surface preparation is absolutely essential for effective performance by any protective coating. Most failures of protective coatings can be traced to poor adhesion caused by inadequate surface preparation. It is especially futile to put a high-grade, costly coating on a low-grade surface.
2. The cost of surface preparation is part of the cost of a protective coating. It is always a significant proportion of the total cost and often it is more than half.
3. Differences in the cost of surface preparation for various types of protective coatings may be significant because of the nature of the equipment that happens to be available, the cost allocation system used, etc. If so, these differences must be considered. But generally the differences are not significant. Organic coatings, for instance, do not require quite as clean a surface as electroplates or vitreous coatings but, on the other hand, they should be applied over a somewhat roughened surface.

Limitations

In addition to the factors discussed above, the following limitations have been observed in this article:

1. Environmental temperatures are assumed to be below the normal boiling point of water.
2. Protective coatings used where wear is the major problem are not discussed, and coatings used solely for added decorative effects are not emphasized.
3. Not all protective coatings which might conceivably meet a general environment condition are discussed. Instead, those most widely used are emphasized in the belief that technically and economically they will generally prove most satisfactory.

Protection Against the Atmosphere

Although the atmosphere is certainly one of the milder service conditions encountered by metal products, it is frightening to contemplate the amount of damage done by the mixture we breathe all the time. However, metals, like humans, get along better in some kinds of air than in others. In talking about corrosion, it is customary to divide all ordinary atmospheres into four types, roughly in order of increasing severity: indoor, rural, industrial and marine. Such a division has been made in this article, but its abitrary nature should be kept in mind.

Indoor Atmospheres

The protective coatings discussed in this section are intended for use where the principal corrosive influence is the atmosphere ordinarily found within a home, office or public building not located in a highly industrialized area. To be practical, these coatings must usually be versatile enough to resist occasional exposure to spilled water, oily fingers or hot food. Coatings for products whose actual function involves environments more complex than the indoor atmosphere, however, are discussed in later sections.

Iron and Steel

Three relatively inexpensive coatings particularly adapted to small parts where appearance and durability are not too important are: 1) amorphous phosphate plus oil, wax or dyes; 2) black oxide plus oil; and 3) sherardized zinc. The zinc coatings are commonly used on nuts, bolts, screws, washers and other fasteners. Since neither the phosphate nor the oxide coating alone offers effective corrosion protection, the value of such coatings is decreased under conditions which tend to remove the oil, such as heat, mechanical wear and solvent action. Nevertheless they are widely used on machine parts, gears and ordnance parts. Since the coatings are only a few tenths of a mil or less in thickness, they can be made ineffective with only moderate mechanical damage. The appearance of the phosphate coating can be varied depending on the choice of organic dye. The oxide coating is black, ranging from dull to lustrous depending on the prior surface finish of the steel.

For a durable, attractive finish the alkyd-urea baking enamels are probably most widely used. A primer and top coat, each about 1 mil thick are

Types of Coatings

The following section summarizes briefly some of the most important factors involving the selection of the different types of protective coatings—conversion, organic, metallic and vitreous. It also compares these four groups, indicating generally under what circumstances each might be most likely to be considered for use.

Conversion Coatings

From a production viewpoint it is common to regard the so-called conversion coatings as part of surface preparation. From the viewpoint of materials engineering, however, it is clear that such coatings are as much a part of a protective coating system as the primer under a coat of paint.

Primarily, the surface conversion processes provide a nonmetallic surface or coating which is closely bonded to the metal. Such coatings are sometimes the only protection applied to light metal parts and zinc die castings. Invariably on steel, and often on the other metals, however, these coatings are used as a base for organic coatings. They offer three advantages:

1. Better adherence of paint, varnish or lacquer.
2. The amorphous coatings are good retainers for oil and wax coatings.
3. They prevent undercutting of the organic film from the point where it is damaged.
4. They sometimes offer a certain amount of anodic protection to the base metal.

When used alone, surface conversion coatings generally offer the cheapest possible protection. However, a variety of processes are available for applying conversion coatings and they vary widely in cost. The anodic finishes on aluminum and magnesium are the most expensive but they are also much more durable and wear-resistant than the other types.

Organic Coatings

As used in this article, the term "organic coatings" includes mastics, linings and adhesive tapes, in addition to paints, varnishes, lacquers and enamels. Mastics and linings are used mainly in the chemical industry and tapes primarily on pipelines. The others, which are the most common organic coatings, also suffer the most from confusion in terminology.

In this article, these terms will be used as follows:

Paint—any pigmented organic coating which sets up by chemical reaction to an opaque solid film after application as a thin layer.

Varnish—an oil-resin composition which sets up by chemical reaction to a transparent or translucent solid film after application as a thin layer.

Lacquer—a thermoplastic, pigmented or not, which sets up by solvent evaporation to a solid film after application as a thin layer.

Enamel—a paint which forms an especially smooth film.

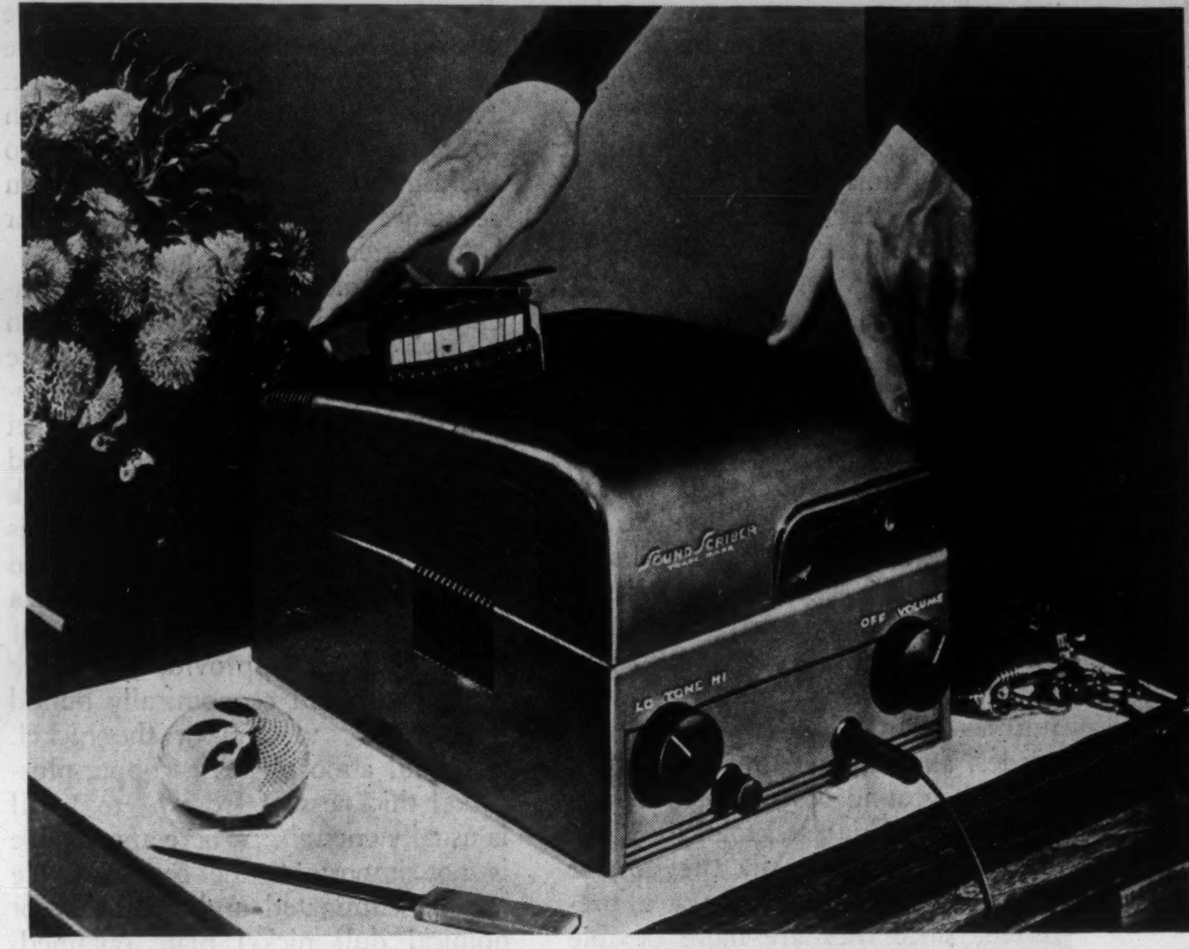
From the standpoint of production rates and cost, the drying characteristics of paints, varnishes and lacquers are one of the most important factors to consider. Lacquers are inherently fast-drying and their drying rates can be speeded up by low temperature baking. A low temperature bake is often used anyway as it improves adhesion, strength and surface of the lacquer. Paints and varnishes are available in both air-dry and baking types. Baking types are invariably used (where practical) if high production is needed, and drying time varies inversely with the baking temperature.

The number of applications is also important. Clear lacquers are often applied in a single coat where the object is to retain an attractive metallic appearance without tarnish. Usually, however, more than one coat of paint, varnish or lacquer is applied, the object being to achieve a porosity-free finish and a certain minimum thickness, depending on the physical characteristics of the film and the severity of its environment. For moderately severe environments a minimum thickness of 5 or 6 mils in a minimum (and maximum, if possible) of three coats is generally recommended. In any multi-coat system, the thickness (or "build") per coat and the drying time between coats are of great economic importance.

A paint, varnish or lacquer with given

commonly used. They are usually applied over a crystalline phosphate coating which prevents peeling of the paint in case of atmosphere penetration, in addition to promoting better adhesion. Typical applications are refrigerators, sinks, stoves, washing machines, etc. Formulation of these paints can be varied considerably to provide the hardness, flexibility and specific chemical resistance needed in such applications. Usually they are pigmented white and dry to a smooth, glossy finish. An important limitation of these enamels is their gradual color change over a period of time to an off-white shade. Pigmented cellulose lacquers offer similar physical properties and can be furnished in a wide variety of colors. Hot spray application is widely used in production finishing.

Better long term protection, especially under high-humidity conditions, can be obtained with such finishes by using an underlying layer of zinc, a few tenths of a mil thick. Alkyd enamels can be applied directly on the galvanized surface, provided a



***BAKED WRINKLE FINISH** is used on this die-cast magnesium housing.*

final film properties can usually be obtained in a variety of formulations depending not only on the drying characteristics desired but also on the method of application. Most common methods of application are dipping, spraying and brushing. Most of the recent development in methods of application has been centered on spraying. The techniques of electrostatic spraying and steam spraying (which can be used together) make possible significant cost savings.

As a group, organic coatings have these advantages:

1. They are usually less expensive than metallic or vitreous coatings.
2. They can be formulated in a wide variety of colors and textures for consumer appeal.
3. They are more flexible than vitreous coatings.
4. They can be used with metallic and conversion coatings.

Chief limitations are:

1. They are generally less abrasion resistant than either metallic or vitreous coatings.
2. Service temperatures are limited depending on the particular type.

Metallic Coatings

Like all other types of protective coatings, metallic plates act as a physical barrier between the base metal and the environment. In this respect their efficiency depends upon their lack of porosity. Lack of porosity is particularly important in many cases because the presence of some metals (where both the plate and the base are in contact with an electrolyte) will actually hasten corrosion.

However, a similar galvanic effect, but in the opposite direction, can be used to advantage with some metallic plates. With zinc, cadmium and aluminum on steel, for instance, porosity is not so critical because the galvanic couple protects the steel at the expense of the coating. This protection, in the case of zinc and cadmium, actually extends beyond the area covered by the plate. Also, a porous metallic plate is generally a good base for a paint or lacquer which, at the same time, effectively seals the pores.

From the above, it can be seen that metallic plates perform one or more of three protective functions: barrier, sacrificial protection and paint base. The proper thickness of a metallic plate depends on which of these functions it is expected to perform and on the nature of the corrosive environment. In any case, the coating must be thick enough to compensate for its loss in thickness due to corrosive action over the intended life span. In the case where the plate offers no sacrificial protection to the base metal, it must have sufficient additional thickness to insure lack of porosity throughout its intended life span.

The problem of thickness and porosity makes the method by which the metallic plate is applied just as important as the nature of the metal itself. Lack of porosity can be insured by welding on thin cladding. This method is sometimes used with tantalum and the noble metals and is often cheaper than electroplating the thick coatings needed. Such cladding also has good mechanical durability.

Fairly thick coatings can be obtained by hot dipping. Except on simple shapes, such coatings are quite non-uniform and the unnecessary thickness applied in order to insure adequate minimum thickness makes this method inapplicable to expensive coating metals. For thick coatings of metals like zinc, tin and terne, however, it is somewhat less expensive than electroplating. The alloy layer formed by diffusion of the hot coating metal into the base makes the plate slightly less deformable than electroplate.

Thick coatings are also applied by spraying. Where their porosity is undesirable it is sometimes reduced by increasing thickness or by hammering, wire brushing or heating the coating. Zinc and aluminum are often sprayed on steel, since porosity is not critical. Despite porosity, these coatings are fairly hard due to the workhardening which occurs on impact. They do not have as good adhesion as plates applied by most other processes.

Thin coatings are usually applied by electroplating. Mechanical properties and brightness of these plates can be controlled within a wide range in the plating bath. Except for simple surfaces, they are not

(Continued on next page)

zinc dust pigment is incorporated in the primer. A smoother finish, however, is obtained if the galvanized surface is first given a crystalline phosphate coating, in which case the zinc dust primer is not needed.

More durable and more resistant to heat, food acids, etc., than the alkyd-amines is a new silicone-base baking enamel. However, it is also more expensive.

For products that are expected to have useful lives of five or ten years or more and must have an attractive appearance, a titanium-type porcelain enamel is often specified. If a special titanium-bearing killed steel is used, or if a flash of nickel is first plated on an ordinary enameling steel, only one coat, 3 to 4 mils thick, need be applied for a high-gloss finish. With ordinary enameling grades, and without the nickel flash, a cobalt ground coat of 3 to 4 mils is needed, making the total thickness 7 to 8 mils. Generally the thinner porcelain enamel coatings are preferred, since they are more flexible and therefore less likely to crack and fail as a result of flexure in service. Porcelain enamels are more expensive than the alkyd-urea enamels and have less resistance to mechanical shock. However, they have better adhesion to steel, are more impermeable to the atmosphere, have better abrasion resistance and retain whiteness or color better.

Where mechanical durability, including both impact and abrasion resistance, is important nickel plate is often used. Since its physical properties approach those of mild steel it is not as likely as organic and vitreous coatings to peel or crack during normal service. Nickel is sometimes electroplated directly on steel and sometimes applied over a flash of copper. Main purpose of the copper is to provide a surface more easily and economically buffed than either the steel or the nickel. For mild atmospheres a copper-plus-nickel thickness of from $\frac{1}{2}$ to 1 mil is usually enough. Where appearance is not important, the copper strike can be eliminated and a fairly economical dull nickel plate obtained. Better appearance can be obtained by buffing and "bright nickel plating". However, despite its generally good corrosion resistance, nickel tarnishes to a dull finish. A bright finish must be protected with a clear cellulose lacquer applied by dip or spray.

If the inherent mechanical advantages of a metallic plate are needed and pleasing appearance is desired, it is customary to add a flash of chromium to nickel plate. The chromium plate is usually only about 0.02 mils thick and does not add much to the effectiveness of the nickel plate, but it is resistant to tarnishing and provides an abrasion resistant surface. A tarnish-free surface can also be obtained with tin-nickel plate, a coating requiring less nickel than the nickel-chromium plate.

On a basically corrosion resistant and attractive material, such as stainless, a clear lacquer is sometimes applied to protect against fingerprints.

Zinc

Zinc does not corrode rapidly in ordinary atmospheres, but takes on

Types of Coatings

(continued)

uniform, and it is best to specify minimum thickness desired on significant surfaces. Because of the shortage of nickel, thicknesses of nickel plate specified in this article are generally unobtainable today.

Other methods are sometimes used. Cementation, because of the high temperatures required, is generally restricted to steel. Coatings of zinc (sherardizing), aluminum (calorizing) and chromium (chromizing) are sometimes applied by this method. Vapor deposition, cathode sputtering and chemical immersion are used for special cases.

The metals most commonly protected by metallic plates are steel, copper and zinc. Plates on the light metals are not uncommon now, but their main purpose is to achieve certain decorative effects.

Principal advantages of metallic plates are these:

1. Better wear resistance than most organic coatings.

2. Better ductility than vitreous coatings.

3. Higher reflectance than either organic or vitreous coatings.

Principal disadvantages are:

1. They are attacked by corrosive environments. Products of such attack sometimes contaminate the environment undesirably.

2. For mild environments, they are expensive compared to organic coatings.

Vitreous Coatings

Because of the high temperatures required to fire them, porcelain enamels are generally applied only to iron and steel. However, special types which can be fired at much lower temperatures have been developed for aluminum.

Steels for enameling must have extremely low carbon content, freedom from harmful solid or gaseous impurities, resistance to sagging and warping at firing temperatures, good surface texture and uniformity of composition. Standard steels are not usually satisfactory, and it is customary to use "enameling sheets" developed particularly for porcelain enameling. Thickness of the sheet and rigidity of the structure must be sufficient to prevent distortion at firing temperatures as high as 1800 F.

Also, porcelain enamels are brittle. Thin coatings are much more flexible than thick coatings which require a heavier section of base metal to prevent damage from flexure. A heavier metal section also improves impact resistance of the coating. Vitreous coatings are somewhat harder than organic coatings and offer good protection against wear and abrasion.

It is hard to classify porcelain enamels for steel into convenient groups, as they are usually formulated to meet specific conditions. Ground coats are fairly well standardized. Cover coats are made with infinite variation in the refractories, fluxes and opacifiers. But three general types—titanium, antimony and zirconium—will be referred to in later sections.

Porcelain enamels have been applied to wrought aluminum alloys 2S, 3S, 53S and 61S and to non-porous castings of 43 alloy. Aluminum design must allow for a firing temperature of 1000 F, and the enamels which can be used are less brittle but do not have the chemical versatility of those for steel.

Glass and porcelain enamels offer the following advantages:

1. Extremely high chemical resistance to practically all environments except strongly alkaline ones.

2. They are more impermeable to air and moisture than organic and metallic coatings.

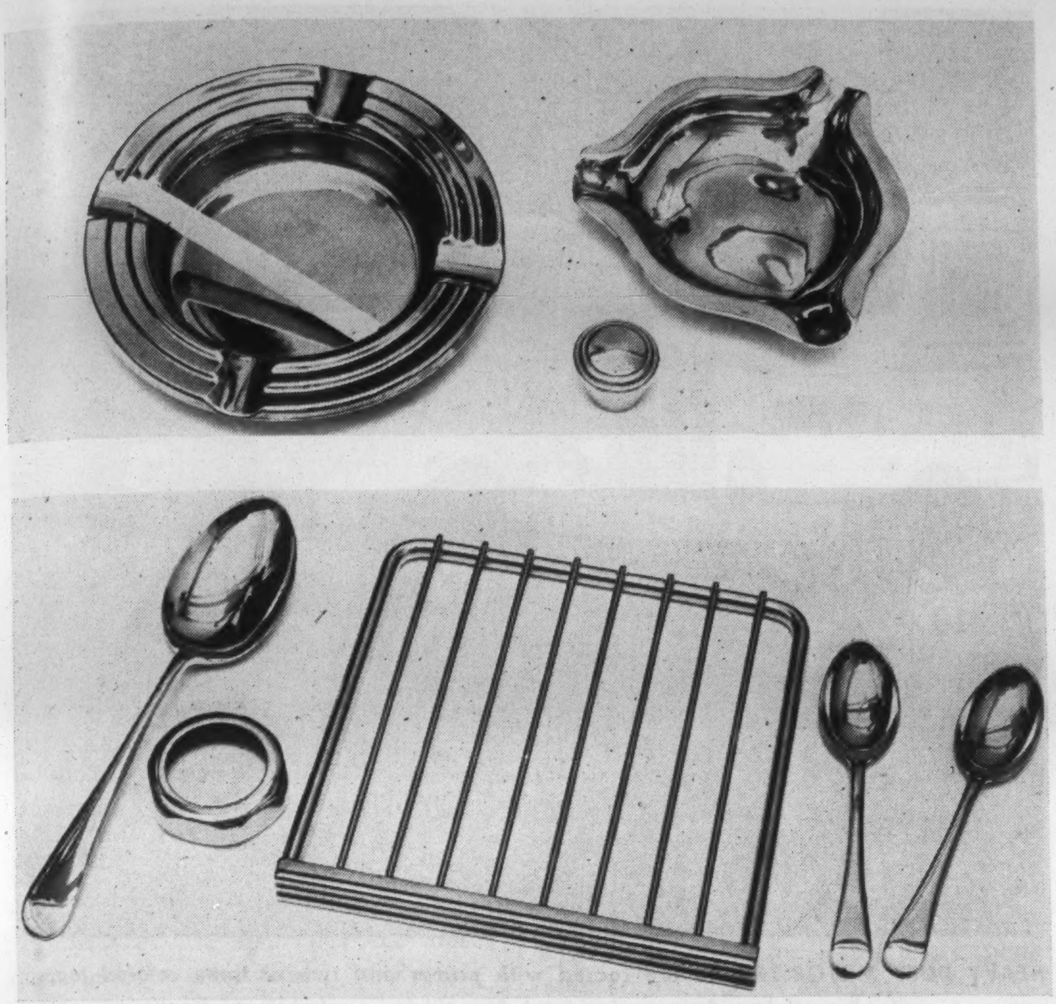
3. Almost indefinite retention of initial appearance.

Chief limitations are:

1. Tendency to chip or crack on impact or flexure.

2. Relatively high cost.

Two recent developments may widen the applicability of porcelain enamels. One is the continuing trend toward lower firing temperatures for titanium-type enamels. Eventually, this may make possible wider use of standard steels rather than the special enameling grades as well as thinner gages. Another is the development of a gas-fired spray gun, still under test, which sprays the molten enamel on the metal surface. If successful, this will eliminate the need for the two separate operations of application and firing and the need for furnaces. This should speed production and lower costs.



TIN-NICKEL *electroplates save nickel and provide a tarnish-free surface, making them a possible alternate to nickel-chromium plates.*

VACUUM CLEANER *is finished with a hot-sprayed nitrocellulose lacquer.*

a grey appearance unsuitable for many applications. Two relatively inexpensive coatings are widely used. Where the durability of an essentially metallic surface is desired, a chromate coating produced by chemical immersion is used. It is only about 0.02 mils thick and has an iridescent appearance. It can be obtained clear, golden-brown, green and black. This coating is widely used on rolled zinc and zinc die castings subjected to hard wear. For more decorative applications, such as trim on interior auto accessories, a cellulose coating of 2 or 3 mils, applied by repeated dipping, is sometimes used.

Where appearance is of primary importance, as on many zinc die castings, the copper-nickel-chromium electroplate is generally used. A copper-plus-nickel thickness of at least ½ mil is common, and the chromium plate is about 0.02 mils.

If color is desired, alkyd type enamels can be used. As on galvanized steel, a choice can be made between incorporating a zinc dust pigment in the primer or applying a crystalline phosphate coating first, which usually promotes a smoother finish. An important factor in the selection of baking enamels for zinc is the low melting point of this metal. The maximum baking temperatures recommended for the common zinc die casting alloys are: 425 F for ½ hr, 375 F for 1 hr, 325 F for 2 hr, and 300 F for 3 hr. For rolled zinc they are:

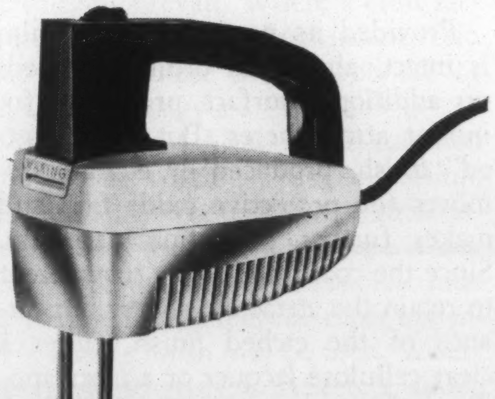
Soft rolled unalloyed zinc..	300 F
Hard rolled unalloyed zinc.	230 F
Soft rolled alloyed zinc...	480 F
Hard rolled alloyed zinc..	300 F

Actually, these limits impose no important restrictions on the use of organic coatings on zinc, as many formulations within these baking ranges are available.

Copper

Like zinc, copper and brass are basically resistant to the atmosphere but tarnish to a relatively unattractive appearance. An inexpensive finish often used where color and reflectance are not desired is a black surface coating, similar in appearance to that sometimes used on steel. Generally it is used where its appearance contributes a particular decorative effect, as in home furnishings.

Another inexpensive coating particularly adapted to many decorative brass and bronze parts is a clear cellulose lacquer. It is especially desirable when used in conjunction with various mechanical finishes, such as hammered and engine turned effects, as it allows both the color and texture of the metal to be seen. A thickness of 1 or 2 mils is usually sufficient. It is also used to protect the



NICKEL-CHROMIUM PLATE *and a baked enamel are used together on the die cast zinc housings of this electric kitchen mixer.*

black finishes. A harder surface is provided by a transparent fuzed glass coating, often used on decorative medals and ornaments. Where a brighter surface is desired a nickel-chromium plate of about 0.2 mils can be used, as on plumbing hardware.

Colorful and glossy finishes can be obtained by two-coat alkyd enamels or by pigmented cellulose lacquers. Because of the good corrosion resistance of copper, no corrosion-inhibiting pigment is required in the primer.

Coatings used chiefly for attractive appearance are thin silver and gold plates applied by chemical immersion or electroplating. Chemical immersion coatings of gold are only a few millionths of an inch thick and are used chiefly on cheap costume jewelry. More expensive and durable gold finishes are obtained by electroplating, a thickness of about ½ mil being common for contact surfaces. Electroplated silver coatings such as those found on household silverware run between 1 and 2 mils in thickness. Still more expensive coatings are applied by soldering gold sheet on brass. For watch cases, for instance, the minimum thickness of gold on the outside is 3 mils.

***HEAVY DUTY MOTOR TRUCKS** are coated with primer and two or three colored topcoats of nitrocellulose lacquer for total film thickness of 1½ to 2 mils.*

Aluminum

Provided its protective oxide film is intact, aluminum ordinarily needs no additional surface protection for indoor atmospheres. But the "frosted" finish, produced by etching, removes the protective oxide film and makes further protection necessary. Since the coating must be transparent to retain the attractive silvery appearance of the etched finish, either a clear cellulose lacquer or a clear anodized finish is used. The anodized finish offers much better abrasion resistance.

Despite its good corrosion resistance and freedom from tarnishing in mild atmospheres, aluminum is often given various decorative coatings to achieve desired color effects. The most inexpensive coating is an oxide produced by chemical immersion. After sealing with potassium dichromate, the coating is yellowish-green. But by using dyes, bluish, greenish gray or nearly black finishes can be obtained.

Colors of much better quality can be obtained by dyes added to anodized coatings a few tenths of a mil thick. Anodized coatings are thicker, harder and denser than the chemical immersion coatings, but they are also more expensive.

Many proprietary chemical immersion oxide coatings for aluminum are available. Many color effects can be achieved by variations in the bath or by organic dyes added to the coating. Such coatings also have a protective function and often increase the abrasion resistance of the surface.

Where the greater flexibility in color and design offered by paint is desired, both chemical and electrolytic oxide coatings are often used as undercoats. For a mild environment, however, it is more common to apply a phosphate coating. The most economical phosphate coating is the extremely thin one produced by a phosphoric acid etch. Much better adhesion is obtained on either the crystalline or amorphous phosphate coatings. A two-coat baking enamel is commonly used over such surfaces, an inhibitive pigment being unnecessary in mild environments because of the basically good corrosion resistance of aluminum.

For a long-lasting, glossy finish, porcelain enamel can be used on aluminum. These coatings, formulated especially for aluminum, consist of a ground coat of 2 to 4 mils and at least one top coat of 4 mils or more. Although porcelain enamels on aluminum cannot be made as thin as on steel, the nature of the formulation is such that they are softer and more resistant to impact.

For highly reflective coatings, either a protected mirror surface on aluminum itself or chromium plate can be used. Mirror surfaces produced by chemical polishing can be protected with little loss in reflectance by transparent chemical or electrolytic oxide coatings. If the appearance characteristic of chromium plate is desired, plates of nickel and chromium can be applied over a zinc immersion coating produced by the zincate process. An intermediate copper strike is sometimes used.

Magnesium

Although magnesium has good corrosion resistance in most atmospheres, its protective film does not retain a metallic appearance but gradually becomes a dark grey. Freshly polished surfaces can be kept bright with a clear cellulose lacquer. A bright surface can also be obtained by a chrome pickle which provides a thin clear film. This coating will maintain a bright appearance at least a year on pure magnesium or M1 alloy, but somewhat less on alloys containing zinc and aluminum. It can be further protected by a clear lacquer.

Other more expensive chromate coatings are commonly used for somewhat better protection. A sealed chrome pickle can be controlled to produce a coating ranging in color from matte gray to yellow-red. Optimum corrosion resistance is provided by a dichromate treatment. This is applicable to all aluminum-containing alloys plus ZK60A, and produces a brown coating.

More variety in color can be obtained by baking enamels or pigmented cellulose lacquers. Paints and lacquers are commonly applied over a chromate coating. Magnesium die castings are sometimes chromium plated to produce a reflective and attractive surface. A zinc strike, followed by 0.5 to 0.8 mils of copper, is used under the nickel and chromium.

Rural Atmospheres

The protective coatings discussed in this section are intended for use where the ravages of rain, sunlight and dust-laden wind, not to mention ice and snow, are added to the natural corrosiveness of the air. To meet these more severe conditions, protective coatings must have greater water impermeability, greater ultraviolet stability and greater abrasion resistance than in indoor atmospheres.

Iron and Steel

All the coatings discussed under "indoor atmospheres" can be used successfully in rural atmospheres, though with generally shorter life. Because of the presence of moisture, it is especially important that metallic plates, such as nickel, which offer no galvanic protection to steel and may even encourage a reverse effect, be thick enough to eliminate porosity. A copper-plus-nickel thickness of at least 1 to $1\frac{1}{2}$ mils is usually required in rural atmospheres for nickel or nickel-chromium plate. Since chromium, in the thicknesses in which it can be commercially applied, offers virtually no protection to the base metal but merely a tarnish-free surface, its thickness does not change with increasing severity of environment.

For large structures where the good paint base offered by phosphate coatings is not practical, a "wash primer" can be used. This inhibitive primer, consisting of polyvinyl butyral, zinc chromate and phosphoric acid, is usually sprayed to a thickness of a few tenths of a mil. Alkyd type enamels, formulated for air-drying or low-temperature baking, are widely used as top coats.

The most durable coatings for steel, especially for mechanical structures, are those of zinc, cadmium and aluminum. Of these, hot-dipped zinc coatings are most widely used. Regardless of the method by which applied, however, zinc protects steel both as a barrier and by galvanic action, the length of such protection being directly proportional to the thickness of the zinc plate. Coatings 1 mil thick may protect steel up to five years. Where appearance is important, a phosphate coating and a paint system can be applied to the galvanized surface as indicated in the section on Indoor Atmospheres.

Under high-humidity conditions bulky white corrosion products may form on the zinc coating. In cases where these would interfere with performance or fail to meet the standard of appearance desired, cadmium plate is sometimes used. Since cadmium itself is currently about 15 times as expensive as zinc, it is not used where zinc is satisfactory. However, tin-zinc electroplates are used as a less expensive substitute for cadmium on electronics components.

Where durable coatings must be applied in place, sprayed zinc or aluminum are widely used. Although adhesion is not as good as with electroplating or hot dipping, performance is satisfactory. Because of the galvanic effect, the porosity of these coatings is no disadvantage and, in fact, offers a distinct advantage in better paint adhesion. Paints or lacquers can be applied directly to these surfaces, eliminating the phosphate coatings.

For ordinary rural atmospheres a 3 mil zinc coating topped by a two- or three-coat vinyl system incorporating aluminum pigment is often recommended. Other systems recommended include 3 mils of zinc plus a coat of chlorinated rubber, and 4 mils of aluminum plus a clear vinyl lacquer. For high humidity conditions 5 mils of zinc or aluminum with a pigmented vinyl system or 8 mils of aluminum with two coats of clear vinyl lacquer are sometimes used.

Other Metals

Zinc—Since for relatively mild environments the main purpose of protective coatings for zinc is to preserve or provide a certain standard of surface appearance, the coatings discussed under Indoor Atmospheres are generally applicable in rural atmospheres also. The simple chromate finish, for instance, is widely used for military items, such as cartridge cases, field telephones and radios, which undergo severe mechanical service conditions. Where chromium plate is used for a highly reflective appearance, a copper-plus-nickel thickness of at least 1 mil is recommended.

Copper—For copper and brass, also, most of the coatings used in mild atmospheres are applied for decorative reasons. The coatings discussed under Indoor Atmospheres are generally applicable to rural atmospheres. Where a clear lacquer is used, however, it is common to specify a more light-resistant resin than nitrocellulose. Cellulose acetate butyrate or methyl methacrylate are often used. Where a nickel-chromium plate is desired, a copper-plus-nickel thickness of about $\frac{1}{2}$ mil is recommended.

Aluminum—All of the coatings discussed under Indoor Atmospheres are used to some extent in rural atmospheres. For severe weathering conditions, however, the anodized finish is the only conversion coating commonly used without further protection. Its thickness can be controlled between 0.1 and 1 mil, depending on the severity of exposure to be met. Both the anodic and the chemical oxide finishes are widely used with lacquers or enamels. An aluminum pigment in the primer is often satisfactory, but zinc chromate is used where high-humidity conditions prevail. Where a clear lacquer is desired, a light-resistant resin such as cellulose acetate butyrate or methyl methacrylate is specified.

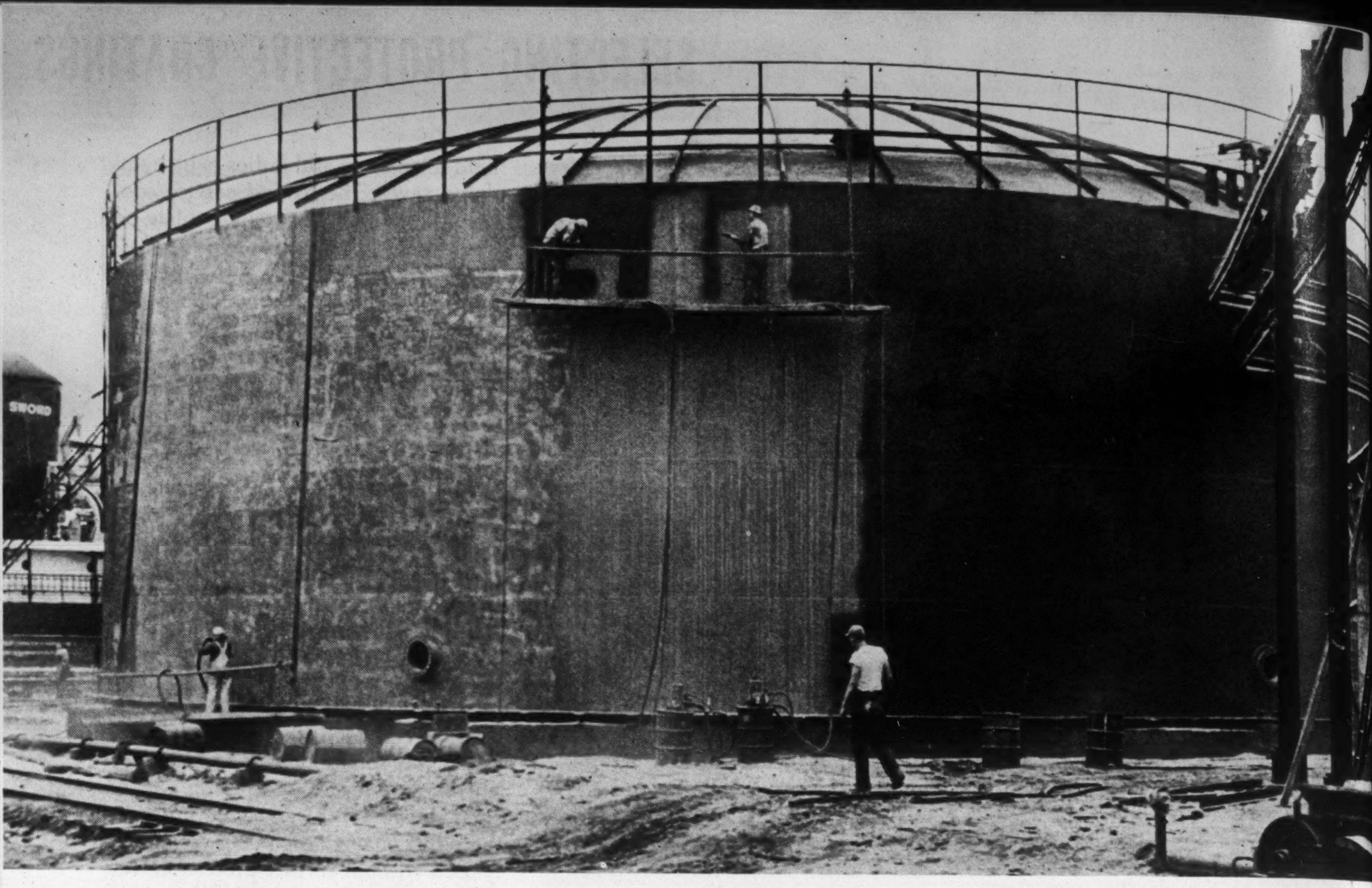
Magnesium—Although all common conversion coatings for magnesium are used to some extent for rural atmospheres, the dichromate type is usually preferred. Where abrasion is likely to be encountered, the more expensive anodic finish may be used. Where severe weathering is expected, added protection is given by baked enamel or pigmented lacquer coatings incorporating zinc chromate pigment.

Industrial Atmospheres

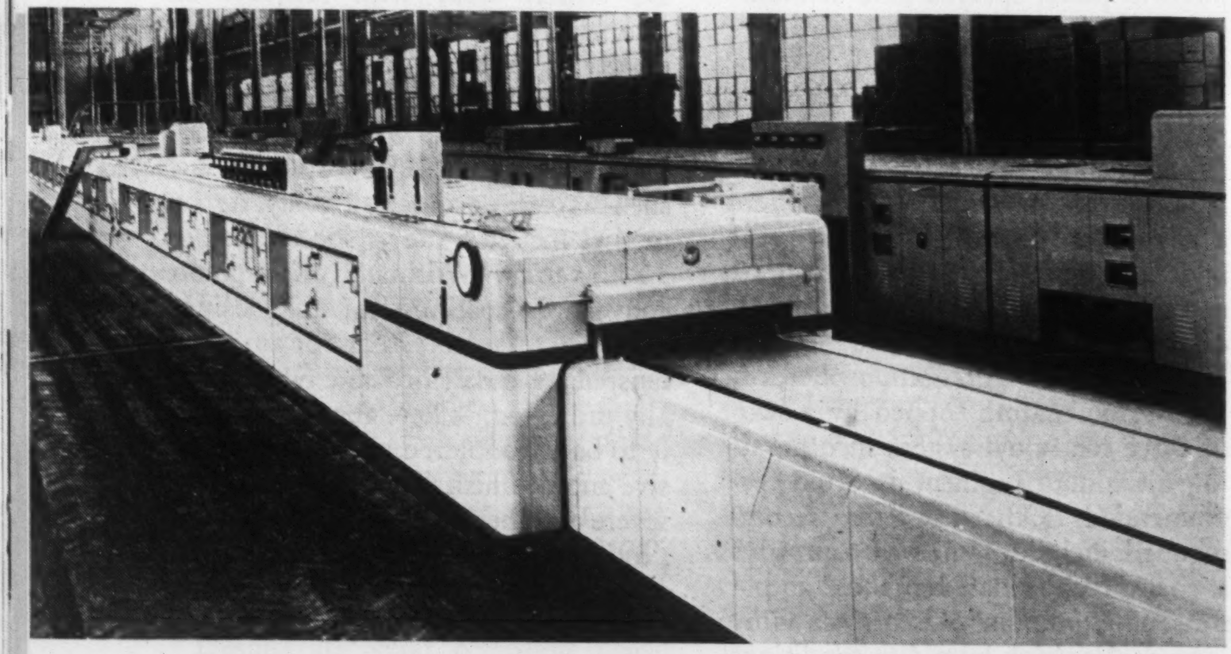
The protective coatings discussed in this section are intended for use where the corrosive influence of fumes of carbon dioxide, sulfur dioxide, sulfurous acid and hydrogen sulfide are added to the difficulties imposed by a normal rural atmosphere. Such conditions are often found in large cities and heavily industrialized areas. To meet these more severe conditions, protective coatings must generally have greater acid resistance.

Iron and Steel

Metallic and organic coatings used



RUBBER-LINED STORAGE TANK *is protected and insulated on the outside by an asphalt type mastic.*



PORCELAIN ENAMEL *9 to 12 mils thick is used to protect this commercial baking oven. An acid-resistant top coat is used.*

on steel in industrial atmospheres are generally thicker than in ordinary outdoor atmospheres, and porcelain enamels must be acid-resistant grades. Conversion coatings are not suitable without maintenance or further protection.

Hot dipped zinc coatings are widely used for ventilators, ladders, bracing, trucks and many other applications in industrial atmospheres, with or without the added protection given by a paint system. But aluminum corrodes much less rapidly than zinc in the presence of dilute acid, and sprayed aluminum coatings are often used in preference to zinc, especially for protecting structures in place. Typical recommendations range from 4 mils of aluminum with a clear vinyl lacquer to 8 mils of aluminum with an aluminum-pigmented vinyl coating system. If aluminum is to be selected in preference to zinc, however, it is essential that complete coverage be achieved. Unlike zinc, aluminum coatings do not extend their galvanic protection of steel to bare or thinly covered adjacent surfaces.

Where softer metallic coatings are permissible, lead is often used. Because of the resistance of lead to sulfurous acid fumes, electroplated coatings of 4 to 5 mils and sprayed coatings of 8 to 10 mils give good protection to steel. Better protection, particularly with sprayed coatings, can be obtained by hammering or shot blasting the lead coating to reduce porosity. Air-dry paint systems incorporating a red lead primer are often used on lead coatings. Lead-coated steel can be severely deformed in service or fabrication without stripping the coating. More commonly used on production items is the lead-tin alloy known as terne. In its commercial thicknesses of less than 1 mil the hot dipped coating is quite porous and is sometimes sealed mechanically or by a paint system. It offers a highly solderable surface.

For industrial atmospheres, a copper-plus-nickel thickness of 1½ to 2 mils is ordinarily used in nickel or nickel-chromium plate. Only acid-resistant (Class A or AA) grades of porcelain enamel can be used. Generally the required properties can be obtained in a one-coat titanium type. Organic coatings applied directly to steel, as the vinyl wash primer plus alkyd enamel system, or over phosphate coatings often consist of at least three coats to eliminate porosity.

Large structures such as storage tanks are often protected by bituminous paints or mastics.

Other Metals

Since zinc is not highly resistant to dilute acids, substantial protective coatings are required in industrial atmospheres. Alkyd baking enamels are commonly used. For chromium plate, a copper-plus-nickel thickness of 1½ to 2 mils is required. Where nickel-chromium plate is to be used on copper or brass in industrial atmospheres, a nickel thickness close to 1 mil is recommended.

For severe atmospheric exposures such as those encountered on trucks, trains and planes, aluminum is most often protected with an aluminum-pigmented paint. Alkyd enamels are applied over a chemical or electrolytic sealed oxide coating and a primer containing zinc chromate. Better acid resistance is provided by a pigmented vinyl lacquer system.

A multi-coat system of alkyd enamel or pigmented lacquer, incorporating zinc chromate, over a chromate surface produced by the dichromate treatment is effective protection for magnesium in an industrial atmosphere. Where a tough surface is required, the anodic treatment is recommended.

Marine Atmospheres

The protective coatings discussed in this section are intended for use where the corrosive influences of salt spray or salt-laden air are added to the difficulties imposed by a normal rural atmosphere. Such atmospheres are found at or in the vicinity of the sea coast. Sodium chloride is naturally corrosive to metals, as its products of hydrolysis are a strong acid and a strong base. Equally important, sodium chloride in water is an excellent electrolyte which not only encourages destructive galvanic action between dissimilar metals, but also, apparently, local galvanic action on a single metal.

Hot dipped and sprayed zinc and sprayed aluminum coatings offer especially effective protection to steel in marine atmospheres. Hot dipped zinc coatings are often used without organic protection, but sprayed coatings are usually sealed with paint or lacquer. Where the surface is not subjected to actual spray, sprayed zinc coatings of 3 to 5 mils plus a two- or three-coat aluminum-pigmented vinyl system are sometimes recommended. Where salt spray is present, 8 mils of zinc or aluminum with an aluminum-pigmented vinyl system; 10 mils of zinc plus a coating of chlorinated rubber; and 10 mils of aluminum with a clear vinyl lacquer are some recommended systems.

Nickel plate seems to resist a marine atmosphere almost as well as a rural atmosphere and plates of 2 to 3 mils might be satisfactory. Chromium plate can be added if desired for high reflectance.

Organic coatings alone must be fairly heavy for long performance. The vinyl wash primer plus at least two coats of pigmented vinyl or chlorinated rubber gives good performance in marine atmospheres. A relatively inexpensive coating used where appearance is not an important factor is a bituminous paint or mastic, depending on the severity of the exposure. A three-coat paint system might be used where no spray is encountered, while a three-coat mastic as thick as 40 or 50 mils might be used in contact with salt spray.

Nonferrous metals, being much more resistant to marine atmospheres than iron and steel, need little protection. Where appearance is important, however, coatings similar to those discussed under "Rural" and "Industrial" Atmospheres are used.

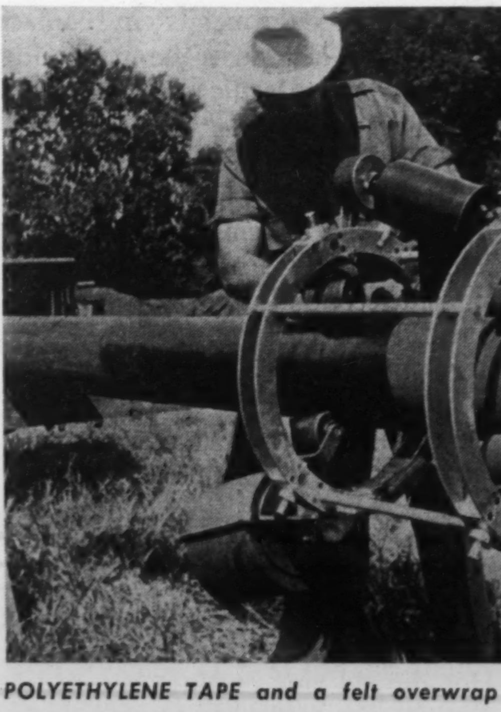
Protection Against Soil

Soils vary widely in their corrosiveness to metal. What we know about their corrosiveness on a practical level is pretty much confined to how fast a metal buried in a particular location is attacked. Now in progress, however, is a broad program designed to correlate this practical experience with information on the physical and chemical characteristics of various types of soils. In the not-too-distant future the selection of materials and protective coatings for underground service will probably be much less empirical than it is now.

Some of the important variables that are known to affect the corrosiveness of the soil are: the amount of water present, the types and relative amounts of dissolved matter, and the conductivity of the soil. The dissolved matter may include organic compounds; gases such as oxygen, carbon dioxide and hydrogen sulfide; and inorganic acids, alkalies and salts. Obviously it is a complex environment.

But there are two factors which tend to simplify materials selection. One is the economic preference for materials whose life span is measured in decades, rather than years or months. The other is the total insignificance of appearance.

Outside of concrete, cast iron and steel are the materials universally used for pipe, tanks and other underground structures. In sufficient section thickness they often serve for many years without protection in certain soils. In other soils protective coatings or cathodic protection (or a combination) are mandatory for economic life. The most widely used protective coatings are concrete, coal-tar bitu-



POLYETHYLENE TAPE *and a felt overwrap are applied simultaneously to pipe by means of a Tapester machine.*

mens and hot dipped zinc.

In mildly corrosive soils, coal-tar base paints, applied hot, are sometimes used. Also used are lacquers based on styrene-butadiene and chlorinated rubber, phenolic varnishes and phenolic-alkyd paints. The rubber derivatives and phenolics form films highly impermeable to water, and baked phenolic-alkyd enamels have been used successfully under severe conditions.

Hot dipped zinc coatings seem to be most effective in neutral, slightly corrosive soils, although they are also used as a base for additional protection in more corrosive alkaline or acid soils. Thicknesses of 3 mils or more are generally required for reasonable life. However, galvanized coatings are generally not economical compared to others more widely used in soil.

Bituminous mastics are the most widely used coatings for pipe. Where practical, coats of about 1/16 in. are applied by hot dipping, a bituminous lacquer being used as a primer. Both coal-tar and asphalt types are used. Coal-tar is more impermeable to water, but asphalt is less susceptible to temperature changes. Bituminous coatings are easily damaged in handling and for that reason are often applied in the field. Also, thicker coatings can be applied in the field. Bituminous coatings are sometimes reinforced with asbestos or glass fiber. One pipe wrap, for example, consists of a bituminous mastic, glass fabric (which is impregnated by the warm bitumens), another coat of bitumens and asbestos fabric. Polyethylene film tape about 8 mils thick and polyvinyl chloride tape are also being used as coatings for pipe.

Protection Against Water

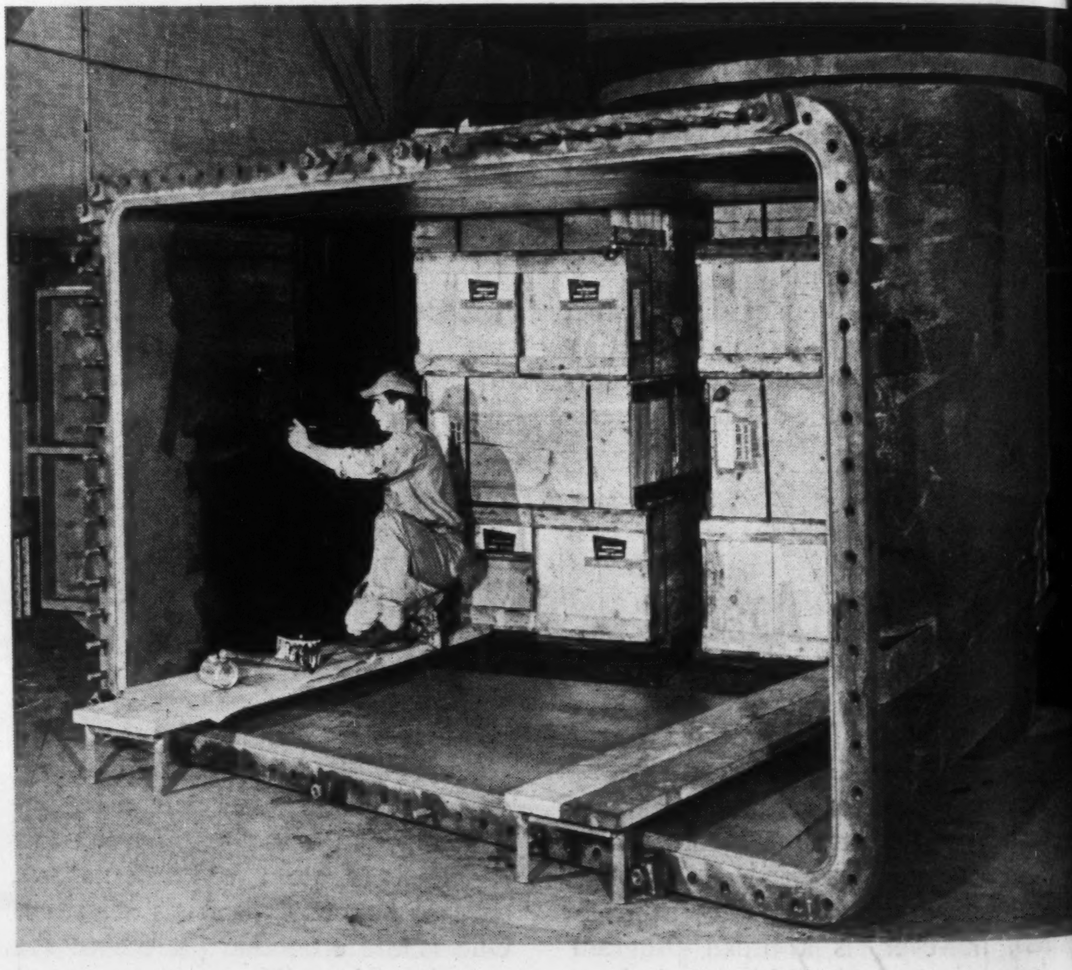
There are probably as many different kinds of water as air, but only two will be recognized here: fresh water and sea water. Other types of water, though often more corrosive than either, can usually be handled with protective coatings similar to those discussed in these sections. Among these other types are mine water, brackish water and distilled water.

Fresh Water

The corrosiveness of fresh water varies widely, depending on many factors. Some of the most important are: oxygen content, velocity, pH, temperature, inhomogeneity and electrical conductivity. These produce both chemical and local galvanic attack. In addition, designs which require dissimilar metals in contact underwater introduce the possibility of general galvanic corrosion. In closed water systems, corrosion inhibitors are often used successfully to prevent attack at minimum expense. In open end systems, however, protective coatings are usually required to insure economic life for metal structures. These coatings must either be impermeable to water or else set up a protective galvanic couple. Often they must resist erosion and somewhat elevated temperatures.

Zinc, aluminum, lead and tin are commonly used durable metallic coatings for steel in water. Of these, zinc and aluminum are most useful because of the galvanic protection they give. Hot dipped zinc coatings are widely used in pipe and hot water tanks for domestic water systems. Although the zinc dissolves slowly, the concentrations ordinarily found are not considered harmful. Interiors of larger tanks are often protected by sprayed zinc coatings of about 10 mils. At temperatures above 140 F, zinc ceases to protect steel galvanically, as a reversal of electromotive potential occurs. Where continuous operation above 120 F is expected and where the mechanical design permits, sprayed aluminum coatings of about 10 mils are used. Lead or tin tubing about 1/16 in. thick is sometimes soldered to galvanized steel pipe. Where water is to be used for drinking, tin is often preferred to lead, as lead content of water must be carefully controlled to avoid poisoning.

Where less mechanical durability

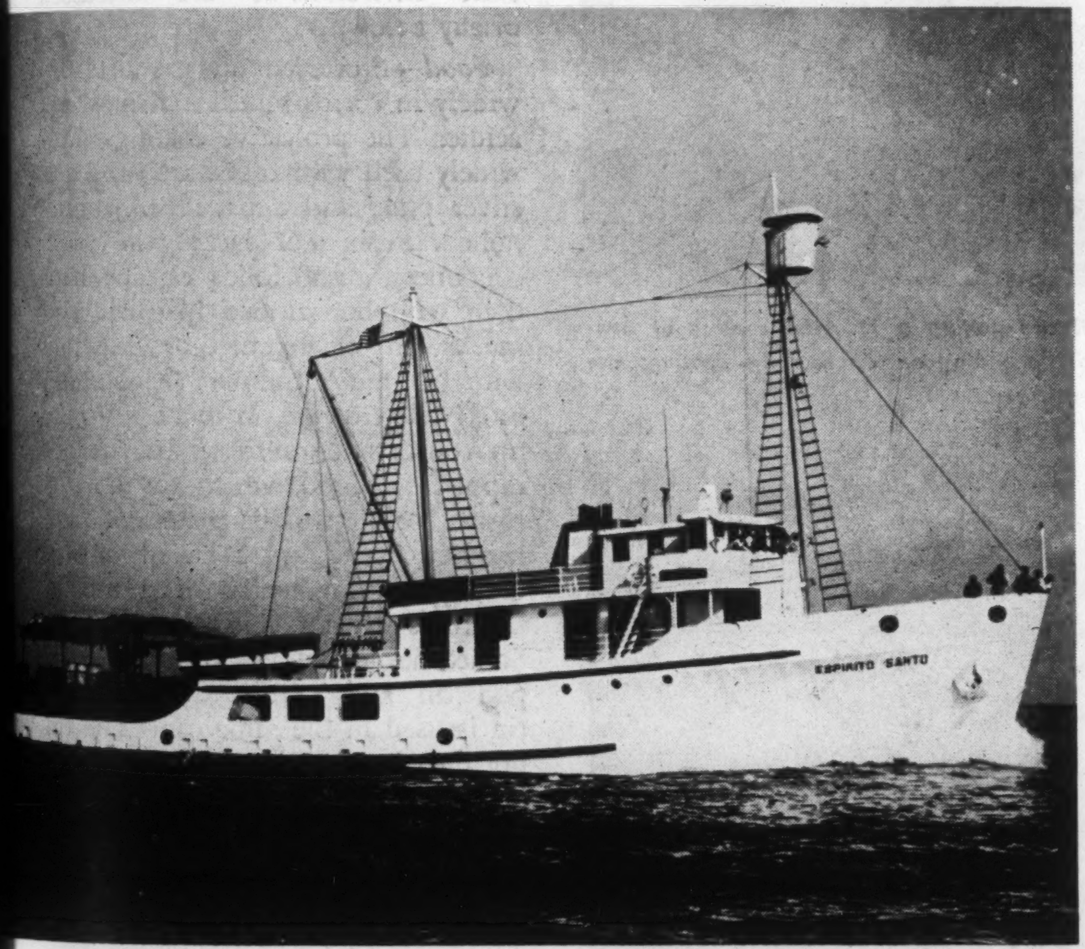


***LIQUID NEOPRENE LINING** is applied to a water condenser box. Each coat can be applied in thicknesses of 6 to 9 mils, depending on whether it is air-dried or heat-cured.*

or shorter life is permissible, or where regular maintenance is possible, paints, varnishes and lacquers can be used. It is important that the principal film former be highly impermeable to water and that the primer contain an inhibitive pigment. Three coats and a minimum thickness of 5 or 6 mils are desirable.

The vinyl wash primer is used with top coats of styrene-butadiene and chlorinated rubber. More traditional are tung oil-phenolic varnishes, sometimes pigmented with flake aluminum for greater impermeability. A baked, alkyd-phenolic enamel is widely used for the interior of water tanks, especially for temperatures above room temperature. Though not as widely used, the furanes and epoxies have water resistance similar to the phenolics.

Interiors of pipe are often protected by 1/16-in. coal tar mastics or cement coatings. The cement coatings can range from ⅛ to ½ in. or more in thickness, depending on pipe diameter and specific service conditions such as velocity. In addition to furnishing a barrier, the cement seems to protect the metal by forming a highly alkaline layer between metal and cement.



SPRAYED ZINC about 10 mils thick protects the hull of this boat which is part of a West Coast tuna fleet.

Where appearance is important porcelain enamels are the most common coating for water exposure. Kitchen and bathroom fixtures are typical consumer applications. However, porcelain-lined pipe and containers are also used industrially, especially where contamination from dissolving metallic coatings would be undesirable.

Nonferrous metals have relatively good water resistance. Zinc die castings, for example, can usually be protected satisfactorily by the simple chromate coating. Brass has good resistance to slow-moving water but deteriorates more rapidly in fast-moving water. Tin coatings are sometimes hot-dipped or electroplated on copper tubing. The light metals also have good resistance to water and seldom need further protection beyond a conversion coating.

Sea Water

The protective coatings discussed in this section are intended for use where the presence of sodium and chloride ions and a greater electrical conductivity are added to the difficulties imposed by fresh water immersion. The greater conductivity of the environment encourages local galvanic action, as well as general galvanic corrosion where dissimilar metals are in contact. The sodium ions promote alkalinity at cathode areas and the chloride ions tend to prevent passive films from being formed at metal surfaces.

The most durable protective coating commonly used in sea water is hot dipped or sprayed zinc. Its galvanic function is particularly important because of the high conductivity of the environment, and bare spots on the steel are usually protected within several inches of the coating. Many ship fittings subjected to intermittent or continual immersion are galvanized. Hull plates above the water line are sometimes sprayed with 6 to 8 mils of zinc plus a multicoat pigmented vinyl system. Hull plates below the water line and fish holds and tanks are sprayed with 10 mils of zinc and a coat of chlorinated rubber. Where fouling is a problem, the chlorinated rubber is eliminated, and the dissolving zinc effectively poisons marine growth. On immersed steel piling as much as 15 mils of zinc, plus a coat of chlorinated rubber, may be sprayed.

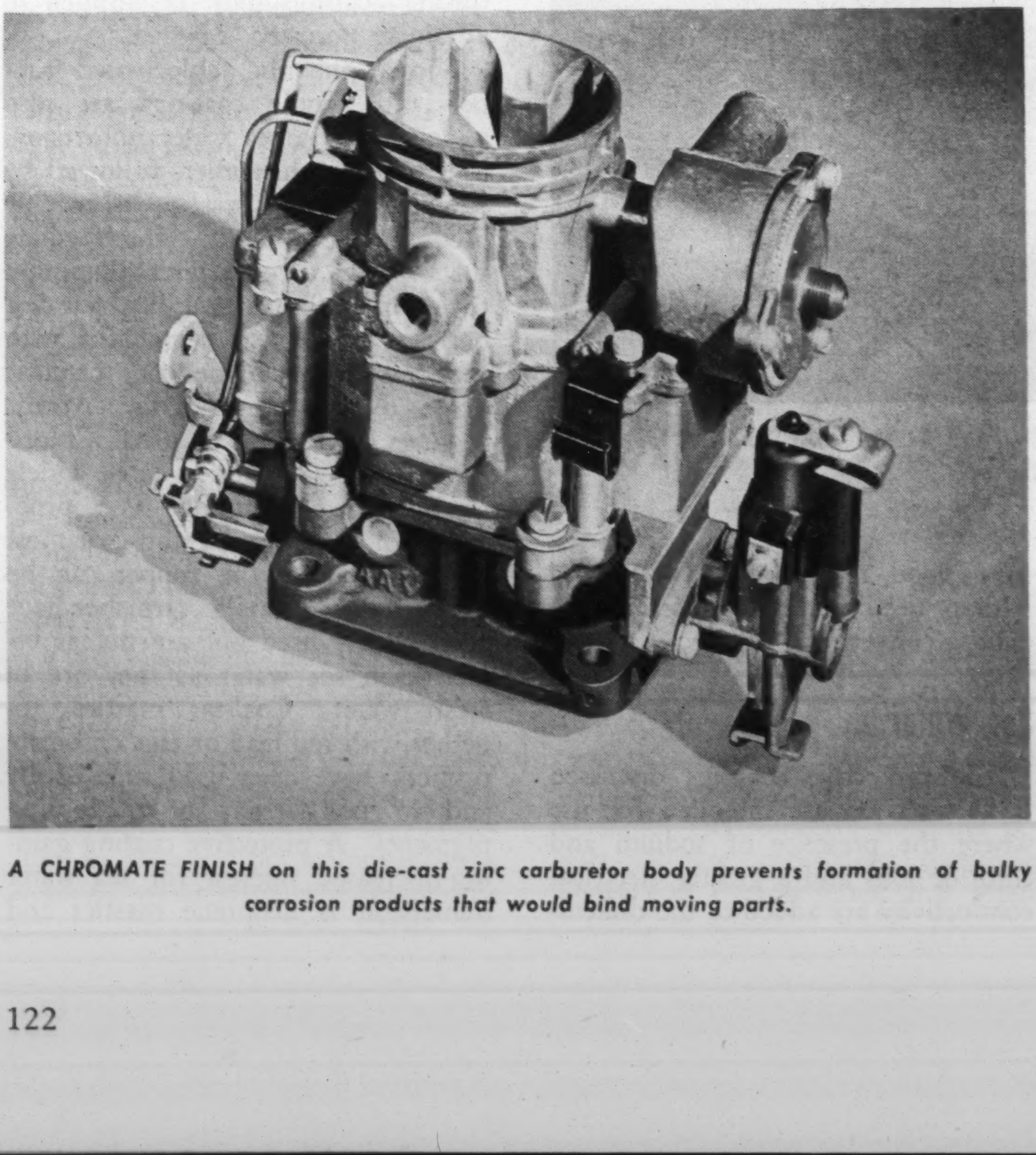
Sprayed aluminum coatings are also used, but are not as effective as zinc in preventing localized corrosion. Sprayed lead is also used but, since it offers no galvanic protection, thicker coatings must be applied to eliminate porosity.

Vinyl, phenolic, chlorinated rubber and acrylic coatings are also widely used in sea water immersion. The vinyl wash primer, followed by a vinyl coating system, is widely used on ship hulls. Intermediate coats are pigmented with aluminum for optimum impermeability to water, but the top coat is pigmented with copper, copper oxide, or mercuric oxide to prevent fouling. Acrylic coatings have also been used. Chlorinated rubber coatings are widely used but, where fouling is a problem, a more permeable top coat must be used so that the copper can be leached out. Phenolic varnishes have been widely used but are not as effective in sea water as they are in fresh water. Coal-tar mastics, together with red lead or zinc chromate primers, have been used successfully and are good carriers for anti-fouling pigments. A protective coating gaining increased interest for sea water immersion is neoprene mastics and sheet.

Although the nonferrous metals have much better resistance to sea water than steel, they are still subject to erosion and fouling. An anti-fouling system used on aluminum consists of a zinc chromate primer, a coat of chlorinated rubber and a paint containing an anti-fouling pigment. Copper is sometimes protected from erosion by coatings of lead-tin solder wiped on.

Protection Against Chemicals

RECTIFIER ROLL (left) and fume impeller (right) are getting a 1/16-in. coating of neoprene. About 7 to 10 applications are needed, depending on whether the coatings are air-dried or heat-cured.



A CHROMATE FINISH on this die-cast zinc carburetor body prevents formation of bulky corrosion products that would bind moving parts.

All environments are chemical environments. As the word "chemical" is used here, however, it refers to environments more specialized and generally more corrosive than the environments discussed up to this point.

Some chemical environments are encountered fairly often in product use, even on a consumer level. Three such environments are discussed briefly below.

Food—Processed food products vary widely in corrosiveness, but most are acidic. The protective coatings most widely used with foods are tin plate, silver plate and a baked alkyd-phenolic varnish. For packing in closed containers, most foods can be handled with hot dipped tin plate and many can be handled successfully with the much thinner (about 0.03 mils) electrolytic tin plate. Where tin conservation restricts use of hot dipped tin, foods which are too corrosive for electrolytic plate alone are handled by adding a baked varnish coating several tenths of a mil in thickness to the electrolytic plate. Sometimes a combination of hot dipped tin and varnished electrolytic tin is used in the same can. The tin not only has good resistance to food acids in the absence of air, but, in that environment, protects steel galvanically. Although the varnish adds to the cost and is usually used only where tin is short, it is sometimes used also when a stain-free can interior is desired for greater customer satisfaction. Tin plates are also used on copper cooking utensils and on refrigerator shelves, and tin-copper plates are used on tableware. Silver electroplates are used for expensive tableware in thicknesses of 1 to 2 mils. They are readily tarnished by sulfides in the atmosphere or in foods.

Soaps—Soaps, especially the new detergents, are fairly strong alkalies. Some materials selection difficulties have arisen in connection with the

Coatings Used in Some Chemical Environments

Chemical	Nickel	Lead	Silver	Tantalum	Platinum	Gold	Vitreous	Natural Rubber	GR-S	Neoprene	Phenolics	Furanes	Epoxies	Vinyls	Acrylics	Rubber Derivatives	Polyethylene	Oil Paints	Bitumens
Acetic Acid	I	—	I	I	I	I	I	I	S	I	I	I	I	F	F	A	F	A	A
Alkaline Salts	I	—	I	—	I	I	—	I	I	I	A	S	S	I	S	S	I	A	A
Ammonia (liquid)	I	I	I	I	I	I	—	I	I	I	F	S	S	I	S	F	I	F	F
Ammonium Hydroxide	—	—	—	I	I	I	—	I	I	I	F	S	S	I	S	F	I	F	F
Boric Acid	I	—	I	I	I	I	I	I	I	I	I	I	I	I	S	I	I	I	I
Chlorides, Non-oxidizing Acid (Al, NH_4, Sb, Ni, Sn, Zn)	I	—	—	I	I	I	I	I	I	I	IS	IS	IS	I	S	F	I	FA	SF
Chlorides, Oxidizing Acid (Cu, Fe, Hg, Sn)	—	—	—	I	—	—	I	I	I	I	I	I	I	I	S	F	I	F	—
Chromic Acid	—	—	—	—	—	—	I	S	S	S	A	F	F	S	S	A	S	A	A
Citric Acid	—	—	I	I	I	I	I	I	I	I	I	I	I	I	—	S	I	S	S
Fatty Acids (Abietic, Stearic, Oleic, Palmitic, etc.)	I	—	I	—	—	—	—	F	F	S	I	I	I	S	S	A	S	F	A
Hydrochloric Acid	I	—	—	I	I	I	I	I	IS	IS	I	I	I	I	S	F	I	F	F
Hydrofluoric Acid	I	I	—	—	I	I	—	I	S	I	I	I	I	S	S	S	IS	F	SF
Hydroxides (Na, K, Ba, Li)	I	—	I	—	I	I	—	I	S	I	A	S	S	I	S	IS	I	A	F
Hydroxides (Ca, Mg)	I	—	I	—	I	I	—	I	I	I	S	I	I	I	S	S	I	S	S
Nitric Acid	—	—	—	I	I	I	I	ISF	ISF	IS	A	SF	SF	IS	S	FA	IS	A	FA
Oxalic Acid	—	—	—	I	I	I	I	I	I	I	I	I	I	I	—	S	I	S	S
Phenol	I	—	I	—	—	—	—	—	—	F	ISF	ISF	ISF	A	A	A	—	—	A
Phosphoric Acid	—	I	I	I	I	I	I	I	I	I	I	I	I	I	S	F	I	F	F
Sulfates, Non-oxidizing (AlK, AlNa, Al, CrK, Fe, FeK, Ni, $NiNH_4$, Ti, Zn, Na, Sn)	—	I	I	I	I	I	I	I	I	I	I	I	I	I	S	S	I	A	S
Sulfates, Oxidizing (Cu, Fe)	—	I	—	I	I	I	I	I	I	I	I	I	I	I	S	IS	I	IS	IS
Sulfites and Bisulfites (NH_4, Ca, Mg, K, Na)	—	I	—	I	I	I	I	I	I	I	I	I	I	I	—	S	I	S	S
Sulfuric Acid	—	I	I	I	I	I	I	IS	IS	IS	I	I	I	IS	S	F	I	F	F

KEY TO SYMBOLS:

I — Direct Immersion.
S — Occasional Spillage, Dense Fumes.
F — Fairly Concentrated Fumes.
A — Contamination in Atmosphere.

The symbol means that coatings of the particular type listed are used successfully in the given environment, and might reasonably be expected to perform successfully in less severe environments (designated by letters lower in the key) containing that particular chemical.

Use of more than one letter indicates especially wide variation in performance. However, actual service testing is strongly recommended in all cases involving environments listed here, particularly since no attempt has been made to indicate the considerable effects of concentration and/or temperature.

Metallic plates are seldom used in these environments except for direct immersion service.

interior of automatic washing machines. Among the coatings that have been developed for such use are phenolic-epoxy baking enamels and somewhat less expensive phenolic-alkyd enamels. Phenolic films alone have good alkali resistance but are too brittle for most applications. Specially formulated porcelain enamels are also capable of withstanding this type of environment. Both porcelain enamel and alkyd-urea baked enamels are used on other consumer items involving exposure to soap, such as kitchen, bathroom and laundry fixtures.

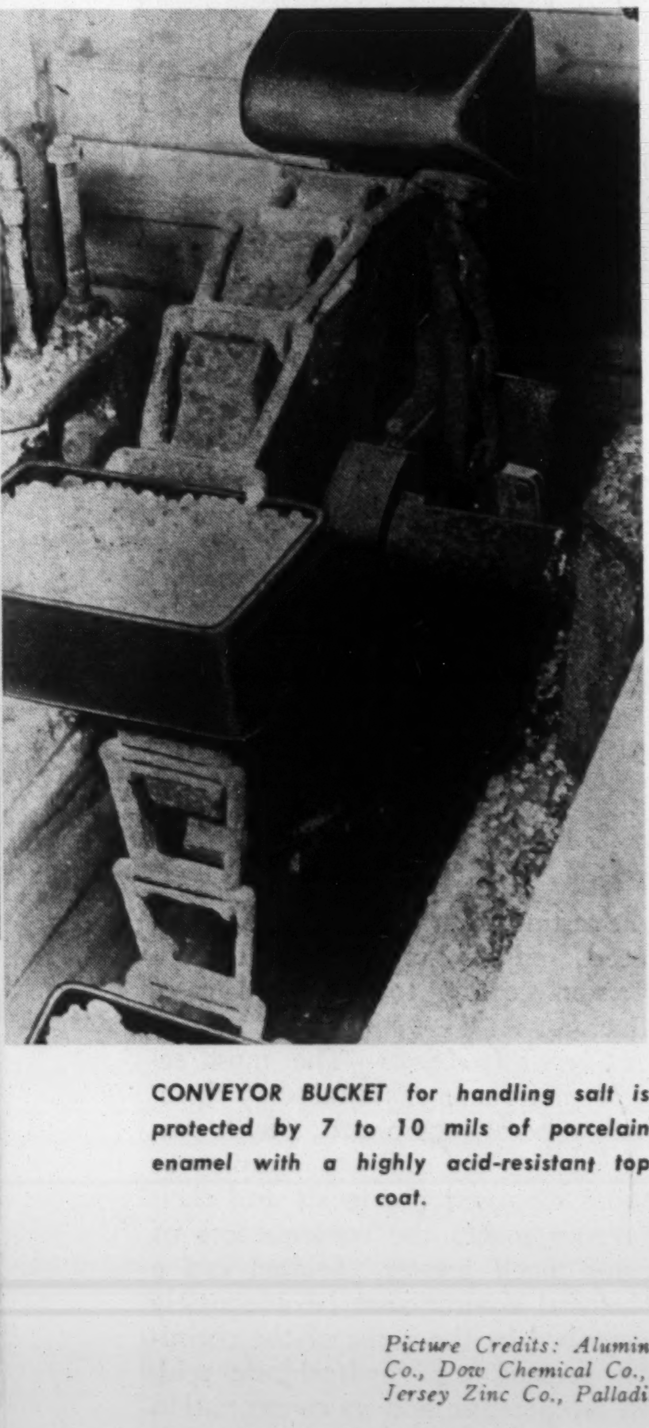
Gasoline—Gasoline, being a physical mixture of many chemicals, varies widely in its corrosiveness. It often manages to pick up water. Phenolic-polyvinyl butyral baked enamels and similar organic coatings are often used for gasoline containers. One protective coating system used for storage tanks is a sprayed aluminum coating with a topcoat of clear vinyl lacquer. Where considerable water and some acid is present, the thickness of both aluminum and vinyl lacquer might be doubled. One precaution that must be kept in mind in using a lacquer, however, is that it is always soluble in its original solvent and probably others as well. Terne plate is widely used for automobile gasoline tank linings. In contrast to steel, a zinc die casting, such as a carburetor bowl, needs only a simple chromate conversion coating to withstand gasoline.

Chemical Agents—The most severe environments are faced by chemical process equipment. Such environments are fully as complex as those discussed previously and their severity makes the consequences of error much greater. Seldom can a chemical environment be adequately described by the name of the chemical present, e.g., hydrochloric acid. Its temperature and its concentration must be known. Even so, a small amount of ferric chloride in the solution would completely nullify any corrosion estimate. It is in such environments that service testing is particularly important if a protective coating which is adequate, and yet the most economical possible, is to be selected.

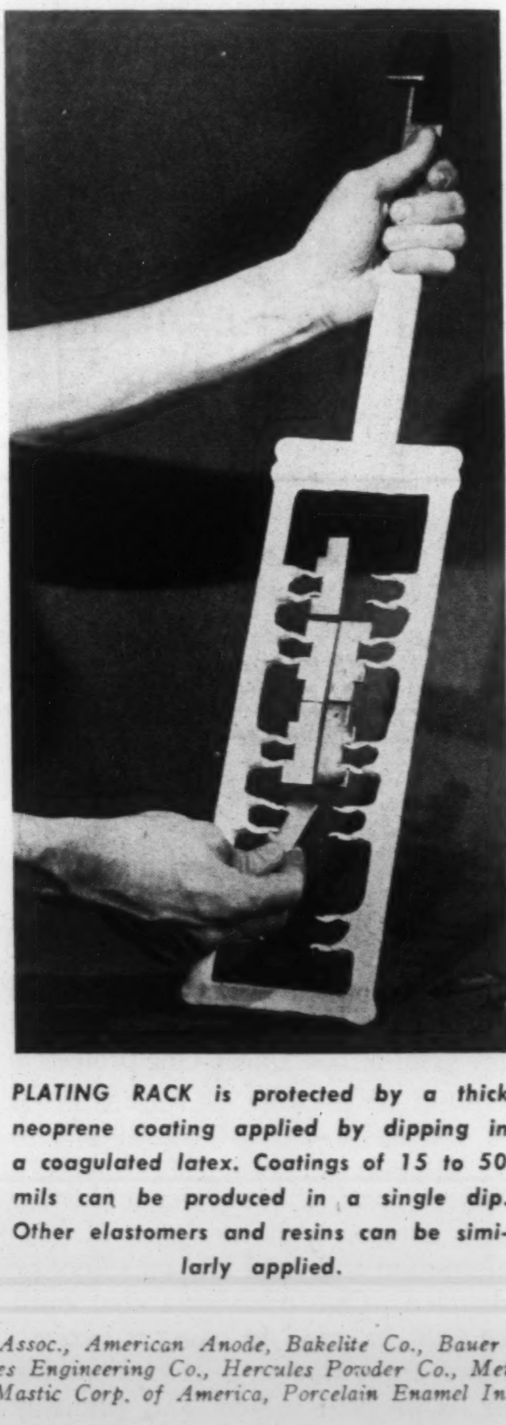
The accompanying table lists a number of chemicals and indicates for each the general usefulness of various types of protective coatings. None of the coatings marked as adequate for immersion service, however, is necessarily adequate under the conditions of a particular application. Temperature, concentration, velocity, impurities, presence of abrasive particles and other factors must be considered. The only practical way to consider them all is by service testing.

Furthermore, the table does not specify any thicknesses. The basic principles involved in selecting the thickness of metallic and organic coatings were summarized earlier. Corrosion experts recommend that where organic coatings are used and the corrosion rate of the base metal in the chemical environment is more than 0.05 in. per year, mastics and linings be used. Organic coatings, porcelain enamel and glass are often preferred to metallic coatings solely because metallic coatings may contaminate the chemical product undesirably. Such contamination is insignificant, however, where it would be eliminated by subsequent processing such as distillation.

As indicated in the table, only metals with a considerable degree of corrosion resistance are considered as protective plates. The porcelain enamels used for acid exposures are the zirconium type, although, in some cases, the titanium type might be used with a thin overspray of the zirconium type. Of the organic coatings listed, "vinyls" include vinyl chloride-acetate, vinylidene chloride and others; "rubber derivatives" include chlorinated rubber and styrene-butadiene; and "oleoresinous paints" refers to alkyd and other oil-formulated finishes. In addition to the types of coatings, listed in the table, polytetrafluoroethylene and trifluorochloroethylene coatings are being used where their high cost is justified by the severe corrosion conditions involved.



CONVEYOR BUCKET *for handling salt is protected by 7 to 10 mils of porcelain enamel with a highly acid-resistant top coat.*



PLATING RACK *is protected by a thick neoprene coating applied by dipping in a coagulated latex. Coatings of 15 to 50 mils can be produced in a single dip. Other elastomers and resins can be similarly applied.*

Acknowledgments

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Materials Engineering File Facts

MATERIALS & METHODS
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Number 258

Granular Powders for Powder-Metallurgical Applications

Production Method or Particle Shape	Mesh Size (Approx.)	Purity	Supplier
ALUMINUM			
Atomization	−200, −325, −400	99.3%	R
Mechanical Stirring	−8+140	Grade I—95 to 97.5%, II—92 to 95%, III—90 to 92%, IV—85 to 90%	Ap
	−35+100	99% min	Ha
(Granular Particles)	−100, −200, −325		MD
Atomization	−24, −40, −100, and various other sizes		Al
	Various sizes	99%	Be
ANTIMONY			
	−100	99% min	Ha
	−100		MD
BERYLLIUM			
	−100, −200	99.50% min	Ha
Mechanical Comminution	Various sizes down to −325	99%	BB
BISMUTH			
	−100		MD
	−100		Be
CADMIUM			
	−100, −300	99.50% min	Ha
	−100, −200, −325		MD
	−100	99 9%	Be
CHROMIUM			
	−100	97.5% min	Ha
Electrolytic	−100 −200, −300	99.00% min	Ha
Electrolytic	−8, −20	97% min	UC
Electrolytic	−100, −200 −325	99% min	UC
	−100		MD
Electrolytic		99.9%	Be
COBALT			
	−100, −200, −300	97.50% min	Ha
	−300 or finer	98 to 99%	Be
COLUMBIUM			
	−80, −200, −400	99.80%	Ha
Hydride Method	−325	90+%	MH
COPPER			
Electrolytic	Various mesh sizes −100 to −325	Various grades: 99 to 99.50%	UM
Electrolytic	−100, −150 −250	Various grades: 99 to 99.75%	Ha
Atomization	−28, −60, −100	99% min	Ha
(Granular or Spherical Particles)	−100, −200, −325		MD
Atomization (Semi-Reduced)	Various size ranges −20, −325	99.33%	Gr
Gaseous Reduction	−100, −200, −325	99+%	Gl
Gaseous Reduction	−100, −200		Ch
Electrolytic	−100	99.5%	AM
Atomization	−28+60, −60+100, −100+200, −100	99+%	NJ
(Fern-Shaped Particles)		99.30%	MM
Electrolytic		99.9%	Be
GOLD			
	−200	998.25 fine	Ha
		999.5 fine	ES
IRON			
Carbonyl	Av. size 3 to 8 microns	98 1 to 98.8%	An
Carbonyl Reduced	Av. size 10 to 20 microns	99 6 to 99.9%	An
Reduction	−100	97.75 to 98.5%	Py
Pulverization	−120+325		B
Sponge Method	−100	97+%	Fe
Sponge Method	−100	97.5+%	E
IRON—Cont.			
Carbonyl Annealed	−325 (10 to 20 microns)		Ma
Reduction	−80, −100, −325	98+%	Ma
Magnetite	−40	97.6 to 97.9%	Ma
Pulverized	−100	98.7%	MP
Hydrogen Reduction	−80, −200, −325	98.5% min	Ha
Pulverization	−200, −100+325	93%	Ha
	−100, −200, −325		MD
Electrolytic	−8 to −325	99.9%	Pl
Sponge	−6 to −325	98.5%	Pl
Electrolytic	−100	99.3+%	J
Sponge	−150	99.3+%	J
Atomization	−35, −85	98.5% min	EM
	−20, −50, −150, −200	90 to 93%	Be
LEAD			
	Various sizes	99%	Be
Electrolytic	−100, −200, −325	99.2%	AE
Atomization	−100	99.2%	AE
Pulverization	−200 mesh (90% thru 325 mesh)	99.85+% pure	NL
	−100, −200, −325		MD
Atomization	−100, −200, −325	99.50%	Gl
MAGNESIUM			
Mechanically Comminution	Mesh sizes to specification	96 to 98%	U
	−100	Mg 93 to 95% (MgO balance)	Ha
	−100		MD
MANGANESE			
	−8	96% min	UC
	−100	99.00%	Ha
	−100		MD
Electrolytic	−20 to −325	99.9%	Pl
Electrolytic	−100	99+%	Be
MOLYBDENUM			
Hydrogen Reduction	−200	99.75% min	Ha
	−80	99.00% min	Ha
Hydrogen Reduction	−80, −200	99.9%	Fa
Carbon Reduction	−80+200, −270	99% min	C
	−100 and finer	99+%	Be
NICKEL			
(Spherical Particles)	−30+60, −40+60, −50+100, −100	Unannealed, 97% min Annealed, 97.25% min	Ha
	−100, −200, −32	Unannealed, 97.5 to 98.5%; annealed, 98.0 to 99%	Ha
(Granular Particles)	−100, −200, −325		MD
(Spherical or Irregularly Shaped Particles)	−20 to −325	98 to 99%	Pl
Electrolytic	−100 and finer	99+%	Be
PLATINUM			
	−200		Ha
RHENIUM			
Reduction	Various sizes	99+%	UT
SELENIUM			
	−200	99+%	Be
	−8 −48, −100	96 to 97% min	UC
	−30+80, −150+325, −325	99 7 to 99.9%	UC
SILICON			
	−100	97% min	Ha
	−100		MD
Mechanical Comminution (Highly Irregular Shape Particles)	−4 to −325	95+%	Pl
	−20	99.75 to 99.95% min	S

(Continued on page 129)

New Plastic Bodies Make Possible Sports Cars for the Average Family

The drawing-board dream of a compact, sports-type family car . . . easy to handle in traffic, economical to buy, operate and maintain . . . may soon come true.

For polyester resin reinforced with glass fiber now permits the construction of *one piece* auto bodies, which greatly reduce sports car assembly costs. The light weight and great strength of such bodies also cut sports car operating and maintenance costs.

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Uses of RCI Products

CANVAS, PAPER AND GLASS CLOTH LAMINATES: PLYOPHEN cresol, phenolic and resorcinol-formaldehyde resins and varnishes; POLYLITE polyester resins.

CARBON PAPER: RCI inorganic chemical pigment colors.

CASTINGS: FOUNDREZ powdered phenolic resins (for the shell molding process); FOUNDREZ liquid phenolic resins and FOUNDREZ core oils (for core binders).

FURNITURE, PLYWOOD, FLOORING, HARDBOARD AND CHIPBOARD: HYDROPHEN phenolic glues; PLYACIEN protein glues; PLYAMINE urea-formaldehyde glues; PLYOPHEN phenolic and resorcinol-formaldehyde glues.

LEATHER: BECKOSOL alkyd resins (for leather finishes); PLYOPHEN resorcinol-formaldehyde resins, SUPER-BECKACITE pure phenolic resins, SYNTHE-COPAL ester gums (for leather adhesives).

LINOLEUM: BECKOSOL alkyd resins and PENTACITE pentaerythritol resins (for linoleum coatings); RCI inorganic chemical pigment colors.

PAINTS, VARNISHES AND LACQUERS: BECKACITE (1) fumaric, (2) maleic and (3) modified phenolic resins; BECKAMINE urea-formaldehyde resins; BECKOLIN synthetic oils; BECKOPOL modified phenolic resins; BECKOSOL (1) phenolated, (2) phthalic-free, (3) rosin modified, (4) pure drying and (5) pure non-drying alkyd resins; KOPOL processed Congo copals; PENTACITE pentaerythritol resins; STYRESOL styrenated alkyd resins; SUPER-BECKACITE pure phenolic resins; SYNTHE-COPAL ester gums; WALLKYD pure drying alkyd resins (for alkyd flat wall vehicles); WALLPOL vinyl-type copolymer latex emulsion (for latex flat wall coatings); RCI inorganic chemical pigment colors.

PAPER: BECKAMINE urea-formaldehyde resins (for adding wet strength, improving the wet rub of starch-clay coatings, and waterproofing starch adhesives); RCI inorganic chemical pigment colors (for paper coloring); STYRESOL styrenated alkyd resins (for paper coating).

PRINTING INKS: BECKACITE fumaric, maleic and modified phenolic resins; BECKC LIN synthetic oils; BECKOPOL modified phenolic resins; RCI inorganic chemical pigment colors.

TYPEWRITER RIBBONS: RCI inorganic chemical pigment colors.

WAXES AND POLISHES: BECKACITE modified maleic resins; SUPER-BECKACITE pure phenolic resins; SYNTHE-COPAL ester gums.

Creative Chemistry . . . Your Partner in Progress

REICHHOLD

RCI

Materials Engineering File Facts

MATERIALS & METHODS
August • 1953
Number 258

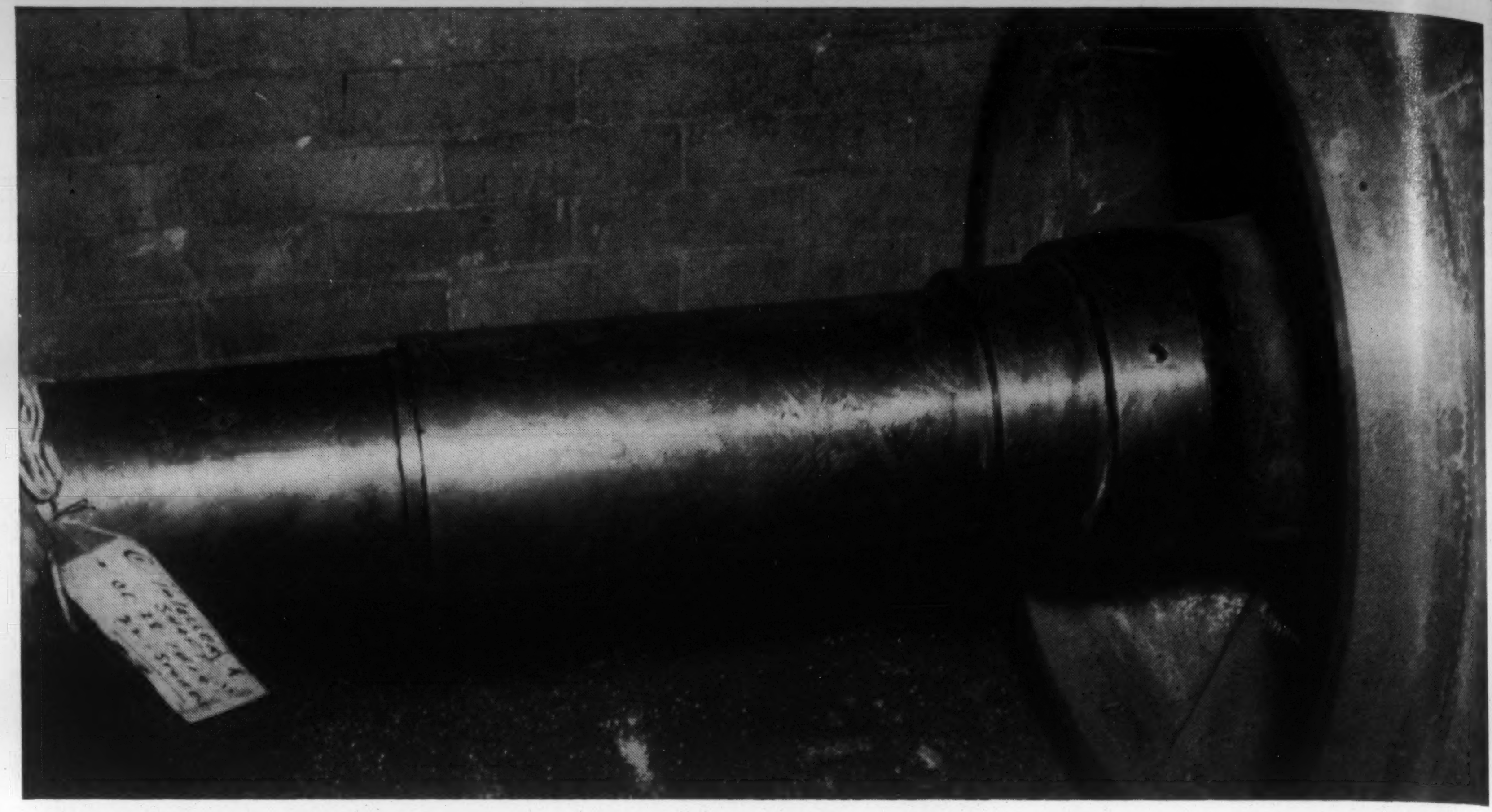
NUMBER 258 (continued)

GRANULAR POWDERS

Production Method or Particle Shape	Mesh Size (Approx.)	Purity	Supplier
SILVER			
Electrolytic	To specifications		UM
Precipitation	−150 (Also other size distributions)	99.9% pure	HH
(Crystalline)	−150, −250	999 fine	Ha
Electrolytic	−100+325		AM
TANTALUM			
	−80, −200, −400	99.80%	Ha
Electrolytic Reduction	−80	99.8%	Fa
	−325, −200	90+%	MH
THORIUM			
	−200, −300		MH
TITANIUM			
	−250	99.50%	Ha
Hydride Method	−325	99+	MH
	−20	99+	T
TIN			
Atomization	−250	99.50%	UM
Mechanical Comminution	−50, −100, −200	Grade A specifications	NL
(Granular)	−100, −200, −325		MD
Atomization	Various sizes		Gr
Atomization	−100 and finer	99.9+%	Be
Atomization	−250	99.50+%	AM
TUNGSTEN			
	−65	98.8%	UC
	1.9 to 2.2 microns	99.6% min	UC
	−80	Technical Grade: 99% min	Ha
Hydrogen Reduction	−325 or 1 to 5 microns	99.90% min	Ha
Hydrogen Reduction	−200	99 9%	Fa
Hydrogen Reduction	Various mesh sizes	99 9%	C
Carbon Reduction	−80+200, −270	98.5%	C
Hydrogen Reduction	−325 (various size distributions available)	99.5% min	S
	−65 and finer	99%	Be
VARIOUS RARE METALS			
Powders of all metals are available			M
ZINC			
	−35, −150	98.80% min	Ha
	−100		MD
Atomization	−20, −52+200, −150, −200		NJ
ZIRCONIUM			
	−250	99.50% min	Ha
Hydride Decomposition	−200	95 to 98% (2 to 3% Hf)	MH
Calcium Reduction	−325 (and other sizes)		FM
Mechanical Comminution	−200	99+%	NL
ALUMINUM ALLOYS			
	−100	HD Grade: Cu 2.3%, Mg 0.3, Al balance	Ha
		HB Grade: Cu 4%, Al balance	Ha
		HC Grade: Cu 4.0%, Mg 0.5, Mn 0.5, Al balance	Ha
ALUMINUM-MAGNESIUM			
Mechanical Comminution	(to specs)	50% Mg, 50% Al	U
		65% Mg, 35% Al	

Production Method or Particle Shape	Mesh Size (Approx.)	Purity	Supplier
BRASS			
(Spherical Particles)	−28, −60, −100	50% to 90% Cu, (some with 0.2 or 0.3 P)	Ha
	−100	Various Cu-Zn compositions with additions of several per cent Al or Pb	Ha
	−100, −200, −325		MD
(Irregular Particles)	−100	Various compositions, 60 to 90% Cu; small % of P or Pb	NJ
(Spherical Particles)	−100	70% to 90% Cu, 30% to 10% Zn with 0.3% P	NJ
Atomization	−100	Various compositions	Gr
	−100	50% Cu and other compositions	Be
BRONZE			
	−30+60	Cu 90, Sn 10%	Ha
	−60+100	Cu 90	Ha
	−100	Cu 90	Ha
	−100+325	Cu 90	Ha
	−100, −200, −325		MD
	−28+160, −60+100, −100	87 to 91% Cu, 6 to 10% Sn, various % of Zn, Pb, or P	NJ
CHROMIUM-NICKEL			
Hydride Method	−100, −150	80/20, 50/50, 20/80, 40/60, also 65/20 with 15% Cu	MH
	−325		AM
COPPER-LEAD			
Atomization	−150	50% Cu—50% Pb (also other compositions)	UM
CHROMIUM-COBALT			
Hydride Method	−325	30/70, 40/60, 70/30	MH
COPPER ALLOYS			
	−60, −100 −200	Cu with either 2%, 3%, or 4% Be	Ha
	−200	P 8.50 to 9.00%, Cu balance	Ha
Copper-Coated Iron		8% Cu-Fe	Ha
Atomization	−100	25 to 50% Cu-Pb	UM
	−100	Cu-Pb-Sn	
	−100	Cu-Pb-Sn-Zn	
Atomization	−100	Various Cu-Pb compositions, with up to 10% Sn and up to 4% Zn	AM
	−100, −200, −325	Cu 80%, Sn 10%, Pb 10%	MD
PHOSPHOR COPPER			
	−100, −200, −325		MD
IRON ALLOYS			
Cu-Fe, Ni-Fe and Mo-Fe	−100	8% Cu-Fe	MP
	−100	18% Cu-Fe	
	−100	1% Ni-Fe	
	−100	3% Ni-Fe	
	−100	1% Mo-Fe	
	−100	3% Mo-Fe	
	−100	8% Cu-3% Ni-89% Fe	
NICKEL SILVER			NJ
Atomization	−100	64% Cu, 18% Zn, 18% Ni	
(Irregular Particles)	−200	64% Cu, 18% Ni, 18% Zn	Ha
STEEL POWDERS			
18:8 Stainless Steel (Irregular-Shaped Particles)	−100	Types 302B, 316, 318 Si and 431	Ha,
Liquid Disintegration Method	−50, −100, −140		TI
	−100	Type 302	Ha
		0.6 to 0.7% C	Ha
		1.3 to 1.5% C	Ha
	−100	Various compositions	Fe
(Made to Specification)			Pl

(Continued on page 131)



Cast to Last *...against salt water, sand and sewage*

At Consolidated Edison's East River Station, they used to replace shaft sleeves in the circulating pumps within $2\frac{1}{2}$ years and often sooner.

There the East River water is both salty and sandy. Sewage and the sandy washoff from streets after a rain are carried by two sewer trunks that empty into the river within 300 feet of the pump intake. Abrasion and corrosion combine to attack the sleeves, as salt water is used in the gland seals.

Finally, the engineers decided to try Inco-Cast "S"® Monel sleeves. These sleeves have already withstood this abrasive and corrosive attack for over four years!

And the way Inco centrifugally cast this hard, corrosion-resisting alloy into the sleeves is a story in itself.

First, Inco designed a carbon insert to be placed inside a regular centrifugal mold. This was so a sleeve could be cast with three varying outside diameters and a constant inside diameter. The job was successful. It saved on metal and also cut the amount of machining needed to finish a sleeve.

Just as Con Edison discovered, Inco-Cast sand or centrifugal castings may be a practical solution to some problem in your plant. Take a look at what you get when you purchase Inco castings.

1. Castings that frequently outlast other materials under destructive service conditions. That's because they are made of Inco Nickel Alloys, especially developed to withstand corrosion, abrasion, erosion and galling.

2. Castings in any practical shape or size you need. Inco has specialized in castings for over 47 years and is equipped to make your castings whether they weigh a few ounces or tons.

3. High quality castings because they are made to meet or exceed Government specifications for these high Nickel Alloys.

4. The benefit of Inco's help in solving your metal problems based on wide experience in field and laboratory testing of Nickel Alloys.

5. Inco Nickel Alloy castings made at Inco's own foundry; your assurance of sound, dependable castings.

6. Even castings you previously thought impractical to produce in Monel®, Nickel or Inconel® can often be cast by Inco.

Do you need a casting that can stand up against corrosion, wear and other destructive service conditions? Let Inco's casting specialists study your problem. We may be able to suggest a practical solution. If so, we will also furnish you with cost and delivery information on any N.P.A. rated order.

In the meantime, write for your copy of "When it's a question of castings . . ."

INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Inco Castings *SAND, CENTRIFUGAL, PREC*ISION

Materials Engineering File Facts

MATERIALS & METHODS
August • 1953
Number 258

NUMBER 258 (continued)

GRANULAR POWDERS

Production Method or Particle Shape	Mesh Size (Approx.)	Purity	Supplier
STEEL POWDERS (cont.)			
	−100	98.5 to 99% Fe	Be
Atomization	−100	Type 302	AE
Atomization	−100	Type 321	AE
Atomization	−100	Type 316	AE
TANTALUM-COBALT			
Hydride Method	−325	15% Ta	MH
TIN-LEAD			
Atomization	−200, −100	35% Sn and other compositions	UM
Mechanical Comminution	−50, −100, −200	40% Sn, 50% Sn, and other compositions	NL
	−100, −200, −325	Various compositions	MD
	−150	85/15, 70/30	Gl
Atomization	−150	Various compositions	AM
	−100 and finer		Be
SILVER SOLDER			
	−100, −200, −325		MD
Mechanical Comminution or Atomization	−20 to −300		HH

Production Method or Particle Shape	Mesh Size (Approx.)	Purity	Supplier
TITANIUM ALLOYS			
Hydride Method	−325	20% Co–80% Ti	MH
		50% Co–50% Ti	
Mechanical Comminution	−80	40% Ti-Fe (low carbon)	NL
	−80	25% Ti-Fe (low carbon)	
Mechanical Comminution	−80	25 to 28% Mn-Ti	NL
Hydride Method	−325	30% Ti–70% Ni	MH
		50% Ti–50% Ni	
		70% Ti–30% Ni	
Mechanical Comminution	−80	Ti-Si-Fe	NL
	−80	25 to 28% Ni-Ti	
ZIRCONIUM ALLOYS			
Hydride Method	−325	30% Zr–70% Ni	MH
		50% Zr–50% Ni	
		70% Zr–30% Ni	
Hydride Method	−325	50% Zr–50% Co	MH
SPECIAL ALLOYS			
		Made to order	PML

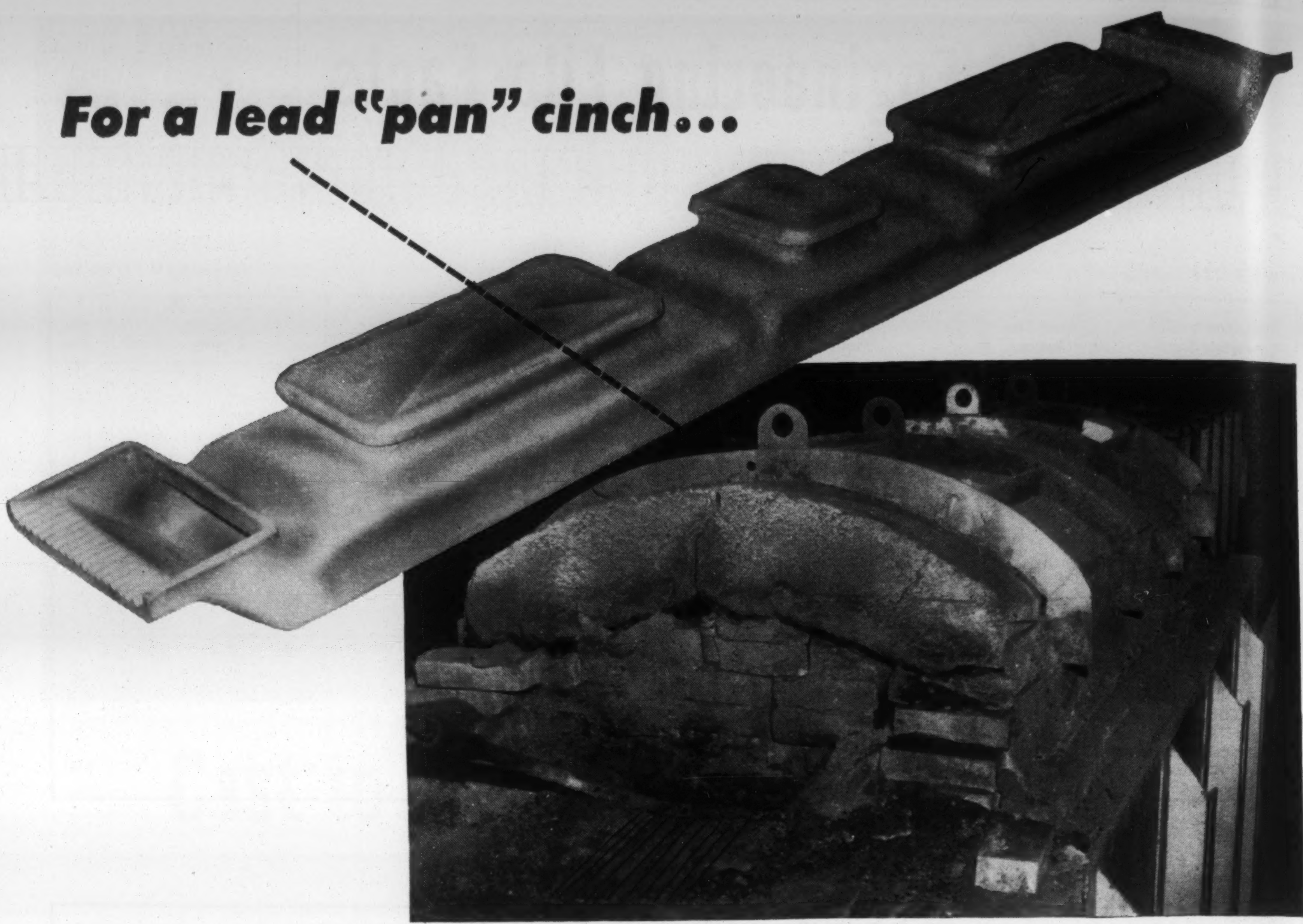
List of Suppliers

Code Letter	
AE	American Electro Metal Corp. 320 Yonkers Ave. Yonkers 2, N. Y.
AM	American Metals Co., Ltd. 61 Broadway New York, N. Y.
Al	Aluminum Co. of America 230 Park Ave. New York 17, N. Y.
An	Antara Chemicals Div. of General Dyestuff Corp. 435 Hudson St. New York 14, N. Y.
Ap	Apex Smelting Co. 2537 W. Taylor St. Chicago 12, Ill.
B	Paul Blum Co. 315 Larkin St. Buffalo 10, N. Y.
BB	Brush Beryllium Co. 4301 Perkins Ave. Cleveland 3, Ohio
Be	Belmont Smelting and Refining Works 320 Belmont Ave. Brooklyn 1, N. Y.
C	Cleveland Tungsten, Inc. 10200 Meech Ave. Cleveland, Ohio
Ch	Chemetals Corp. 488 Madison Ave. New York, N. Y.
EM	Easton Metal Powder Co. Easton, Pa.
E	Ekstrand & Tholand 441 Lexington Ave. New York 17, N. Y.
ES	Eastern Smelting & Refining Corp. 105 W. Brookline St. Boston, Mass.
Fa	Fansteel Metallurgical Corp. North Chicago, Ill.
Fe	Ferrum Ltd. 506 Ste. Madeleine Blvd. Cap de la Madeleine Quebec, Canada
FM	Foote Mineral Co. Berwyn, Pa.
Gl	The Glidden Co. Hammond, Ind.
Gr	Greenback Industries, Inc. 915 Pilgrim Rd. Birmingham, Mich.
HH	Handy & Harman 82 Fulton St. New York 7, N. Y.
Ha	Charles Hardy Inc. 420 Lexington Ave. New York 17, N. Y.
J	A. Johnson & Co., Inc. 61 Broadway New York 6, N. Y.
M	A. D. Mackay 198 Broadway New York, N. Y.
Ma	Magnetic Powders, Inc. Johnsonburg, Pa.
MD	Metals Disintegrating Co. Elizabeth (B), N. J.
MH	Metal Hydrides, Inc. 12 Congress St. Beverly, Mass.
MM	Malone Metal Powders, Inc. 220 W. 42nd St. New York 36, N. Y.
MP	Metal Powders Ltd. 73 5th Avenue Iberville, Quebec
NL	National Lead Co. Metal Division 111 Broadway New York 6, N. Y.
NJ	The New Jersey Zinc Sales Co. 160 Front St. New York 38, N. Y.
Pl	Plastic Metals Div. National Radiator Co. Johnstown, Pa.
PML	Powder Metallurgy, Ltd. 59–62 High Holborn London WC1, England
Py	Pyron Corp. Box 246 LaSalle Station Niagara Falls, N. Y.
R	Reynolds Metals Co. Richmond, Va.
S	Sylvania Electric Products Inc. Tungsten & Chemical Div. P. O. Box No. 70 Towanda, Pa.
T	Titanium Metals Corp. of America 60 E. 42nd St. New York 17, N. Y.
Tl	Vanadium-Alloys Steel Co. Latrobe, Pa.
U	U. S. Magnesium Co. Pleasant Valley, N. Y.
UM	U. S. Metals Refining Co. Carteret, N. J.
UT	University of Tennessee Knoxville, Tenn.
UC	Electro Metallurgical Co. Div. of Union Carbide & Carbon Corp. Niagara Falls, N. Y.

Footnote:
Many of the companies listed here make special mesh size distributions or special alloy compositions to order.

Compiled by Herbert B. Michaelson, Atomic Energy Div., Sylvania Electric Products Inc.

For a lead "pan" cinch...



it's THERMALLOY* to outlast cast iron by 479 days!

A large steel and wire company uses a double-lead patenting furnace to give good drawing qualities to wire. In this process, wire is drawn through a "lead" pan enclosed in the furnace where temperatures range from 1600 to 1650°F.

Previously, cast iron "lead" pans were used . . . and the furnace had to shut down nearly every 21 days because the pan burned out and needed replacement. Then, a Thermalloy "lead" pan with integrally cast sinkers was installed. *To date, this pan has over 500 days of service . . .* saving this company expensive hours of repair and down time.

This is just one example of how a Thermalloy heat-resistant casting has helped a manufacturer to realize more economy in heat-treating parts. Do you have a similar need for Thermalloy in retorts, furnace parts, trays, racks, pots or muffles? Call in an Electro-Alloys engineer for full information, or write Electro-Alloys Division, 4001 Taylor Street, Elyria, Ohio.

THERMALLOY "LEAD" PAN ADVANTAGES

- Resists air-line attack, scaling and oxidation.
- Higher strength prevents sagging and distortion.
- Less weight means easier installation and less maintenance of supporting arches.
- Greater resistance to abrasion.

*Reg. U. S. Pat. Off.

AMERICAN
Brake Shoe
COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

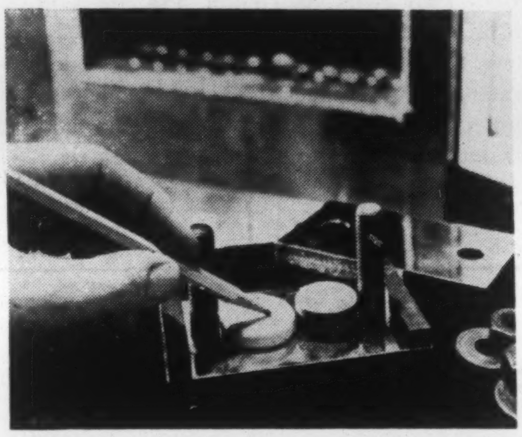
New Silicone Rubber Has Low Compression Set

A new silicone rubber having low compression set and only half the shrinkage of conventional silicone rubber compounds, has been developed by *General Electric Co.'s Chemical Div.*, Pittsfield, Mass. Because of low shrinkage, parts made of this new rubber can be produced in molds originally designed for natural and synthetic rubbers.

Recommended particularly for capacitor bushings and for O-rings and packings in engines where gaskets and seals must remain effective under sustained pressure, the new compound has a compression set of only 8% after 22 hr at 300 F as compared with nearly 100% for organic rubber and about 75% for general purpose silicone rubber. Its water absorption is an unusually low one percent after immersion for one week at 158 F.

The new silicone rubber is designated SE-360 and can be used to produce highly uniform parts from ordinary rubber molds, the company says. It has a total linear shrinkage of 3% after oven cure. Similar compounds generally shrink 6% or more. This low shrinkage feature is expected to effect a saving in the amount of compound required. Conventional press cycles of about 15 min at 250 F can be used, followed by a 24-hr oven cure at 480 F to obtain stated physical properties.

Currently available as a 60 durometer compound, it can be used as a base stock and modified by rubber fabricators to yield 70 or 80 durometer compounds.



Originally the same size, these disks were compressed 50%, baked 22 hr at 300 F. The general purpose material regained 10% of its original height while SE-360 recovered 92%.

Honeycomb Material Offers New Possibilities

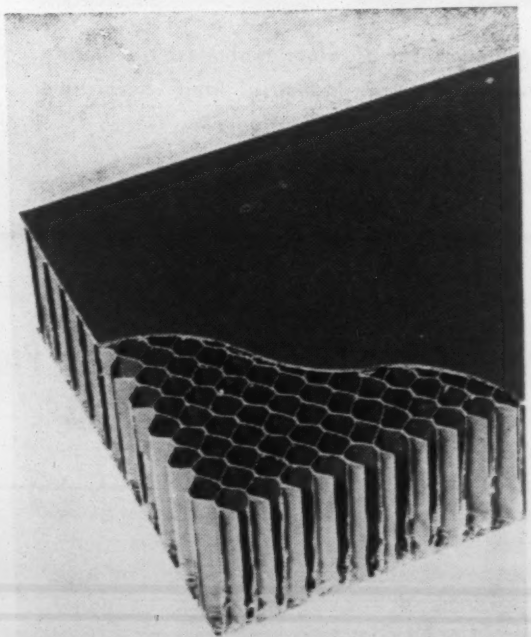
A new structural material now being marketed under the trade name of Aircomb by *Douglas Aircraft Co.*, Santa Monica, Calif., is said to be the strongest material in relation to weight now being manufactured.

The new product is a honeycomb structure of Kraft paper impregnated with a phenolic resin. In use it is sandwiched between thin facings of aluminum, stainless steel, magnesium, wood, plywood, plastics, or a whole host of other materials. It is shipped pre-cut in any thickness from 1/16 to 5 in. and in any length desired. The new material is durable, fire and pest resistant, and it has excellent insulation and soundproofing qualities. A piece of steel of equal rigidity would weigh 16 times as much as Aircomb.

Actually not a brand new product, Aircomb was developed by the company in 1946 after an investigation of available sandwich core materials revealed that existing products in this field were unadaptable to the production of items related to the aircraft industry in which materials of high rigidity, high strength, low weight and consistent quality are mandatory for close tolerance work. During the intervening years, Douglas applied its new product to hundreds of uses in its own aircraft and in other products it builds for the Armed Services. In aircraft, Aircomb is used for storage cabinets, partitions, floors and panels, interior doors, baggage racks, all types of tables and cabin ceilings. In addition, for the military, Aircomb is used to build guided missile fins, wings for robot aircraft, cargo containers, cargo pallets, arctic shelters and radar van trailers.

Research on products produced by other unrelated industries has also been completed to adapt Aircomb for use in office furniture, for flooring, walls, roofs and doors, and other uses within the building trades, and for hundreds of other products that are now made of wood, stone, metal or plastics.

According to the company, Aircomb is in an excellent competitive position with conventional materials and will eventually open up a major new market.



Internal structure of a new honey comb material for use in high strength, low weight applications is shown here.

New Materials and Equipment continued

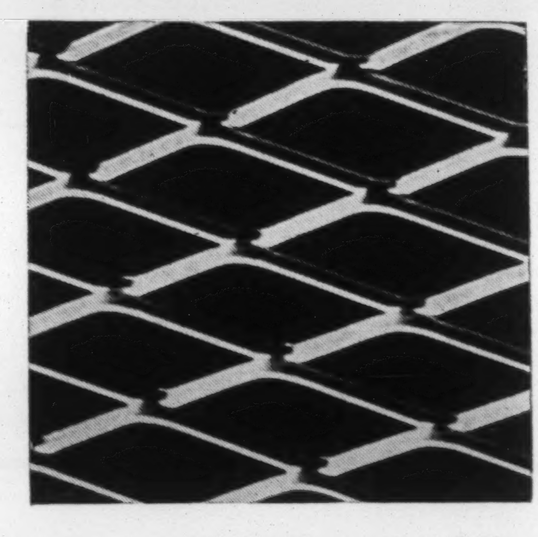
Two New Protective Coatings Resist Chemical Corrosion

Two new protective coatings have been announced by *United Chromium, Inc.*, 100 E. 42nd St., New York 17.

The first is an air-drying modified vinyl coating, Ucilon 454, said to provide a film 3 to 5 times thicker than conventional air drying vinyls. The coating can be applied by ordinary brushing and spraying techniques. When sprayed, it can produce dry films of 0.003 to 0.005 in. per coat. Two coats of Ucilon 454 are said to be sufficient for most applications. The new coating resists acids, alkalies, salts, water, and is especially recommended to protect equipment against petroleum and its derivatives. Having better adhesion than ordinary vinyls, the coating can often be used where, because of the poor condition of the surface, ordinary vinyl coatings could not be used. Under some circumstances it can be applied directly over rusted and scaled surfaces.

The other new line of formulations announced by the company can be spray-applied to produce extra thick chemical-resisting coatings on steel and other metals. These products, identified as Unichrom 5300 coatings, are used to protect equipment against acids, alkalies, salts, oxidizing agents and other corrosives. The coatings permit spray applications of films of much greater thickness than has been available in the past. Used at room temperature, they can be applied to cold vertical surfaces to produce single coat dry films up to 20 mils thick. Even at these thicknesses, practically no sagging is said to be encountered. Both the primer and the coating require short bakes at a temperature of 350 F. The coatings cannot be air-dried. In the short time they have been available, Unichrome 5300 coatings have been used for tank and duct lining work in the plating industry. The manufacturer states that they can be used to protect many other types of equipment in the chemical, pharmaceutical, metal working, food and beverage industries.

Expanded Aluminum Mesh for Grilles



A new form of aluminum mesh is finding many general industrial and decorative applications.

A new form of aluminum mesh, Expamet Expanded Aluminum, has been introduced into the United States by *British Industries Corp.*, 164 Duane St., New York 13. Manufactured in England, the product has been responsible for the decorative effect on Britain's finest loudspeakers and radios. To date, according to the company, no cloth or metal substitutes have been offered in this country which can match the sturdiness, color, and nonresonating character of this material.

Expanded aluminum has many general, industrial and decorative applications. It is made in a variety of brilliant metallic and opalescent colors, and is characterized by diamond-shaped and other special meshes of particular perfection in regularity and finish. It is light in weight, and will not rust; it can be dyed and anodized in a wide range of colors that will not peel, chip or flake and will withstand corrosive attack by most acids.

In addition to its highly decorative use in grilles and other radio and electronic applications, the material serves a valuable purpose in many other industrial applications.

The standard mesh of expanded aluminum is diamond shaped, and it is described and recognized by the measurement across the short way of the diamond. There are 12 standard sizes of mesh from ⅛ to 6 in. short way of mesh, and by using different thickness of aluminum sheet and varying the width of the strand in the process of manufacture, a wide choice of material is made available. Other special meshes are available, differing from the normal diamond shape.

New Stainless Alloy Offers Many Properties

Availability of a new stainless alloy, V2B, has been announced by *The Cooper Alloy Foundry Co.*, Hillside, N. J. Combining high hardness, non-galling characteristics and superior corrosion resistance, the new material was developed to meet the demand for a stainless steel which would not gall or seize in corrosive service.

V2B is a hardenable 18:8 type of stainless steel containing copper, molybdenum, silicone and a very small amount of beryllium. It is readily machinable in the quench-annealed state, and can be hardened by a low temperature heat treatment which produces no distortion and only a light heat tinting discoloration, and which can be readily removed if necessary. In the annealed condition, the material is easily welded using special V2B welding rods. In addition to its use in a wide variety of corrosive applications, the alloy, unlike other precipitation hardenable alloys, does not over-age at elevated temperatures and may therefore be used safely in steam applications and at temperatures up to 1400 F.

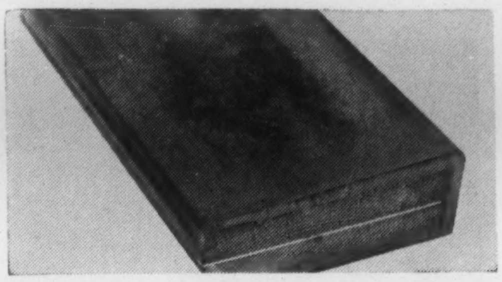
The resistance of the alloy in the hardened condition to sulfuric, hydrochloric and phosphoric acids and their salts, exceeds that of all precipitation hardenable alloys, and even that of type 316, the molybdenum bearing stainless alloy. In nitric acid it is also superior to other hardenable grades, but not quite the equal of types 304 or 316 stainless. Its high hardness and strength, coupled with its excellent resistance to corrosives, plus its erosion resisting and non-galling characteristics suggest many applications: valve disks, plug cocks, shaft sleeves, impellers, pump casings, wearing rings, poppets, conveyor links, rollers and gear blanks.

Plastic Coated Laminated Wood

A new surfacing material highly resistant to abrasives, heat and chemicals, and combined with the weight advantage and mechanical properties of wood, has been developed through the combined efforts of the research laboratories of *Gamble Brothers*, Louisville, Ky., and *United States Rubber Co.* The new material will be available under the trade name of Gam-En-Wood.

Employing U. S. Rubber's thermosetting plastic, Enrup, as a surface material molded over properly selected, cured and machined Gamble hardwood parts, the new material was first tested under the most severe military specifications. It is now ready to fill the long-needed units of industry where surfaces are required to meet the severest manufacturing conditions.

Expected applications include laboratory table tops, flooring, baffles, conveyor rolls and slats, electrical panels, tank linings, railroad crossing planks.



Resistance to abrasives, heat and chemicals are features of this plastic coated laminated wood.

Silicone Rubber Coating Compound for Electrical Insulation

A putty-like silicone rubber coating compound promises marked improvements in electrical insulation and may eliminate many expensive metal cans now protecting coils and other small electrical components. Possessing a unique combination of physical toughness and electrical strength undiminished over a wide temperature range, the versatile new material, offered by *General Electric Co.,* Pittsfield, Mass., also is useful for such non-electrical products as heat resistant engine gaskets and flexible heater ducts.

SE-100 silicone rubber has a higher dielectric strength than any other known silicone rubber coating material, according to the company. The electrical properties of silicone resins ordinarily diminish at elevated temperatures, whereas SE-100 is said to retain its dielectric strength after exposure to temperatures as high as 600 F.

The new material can be coated on glass tapes, glass wrappers and other insulating materials at lower cure temperatures and 30% faster than has previously been possible. As a dipping or encapsulating material it is said to provide electrical equipment with a tough, flexible film that protects against moisture and physical damage at the same time that it insulates electrically.

Whether applied to glass insulation or direct to electrical components themselves SE-100 is suggested by the company as a means of overcoming the cracking problems inherent in brittle resin products.

Heliarc Torch for Heavy Duty Uses

Continuous heavy-duty inert gas arc welding at 500 amp is now possible with the new water-cooled Heliarc HW-12 torch offered by *Linde Air Products Co.,* 30 E. 42nd St., New York 17. Currents of all types—direct current straight polarity, direct current reversed polarity, and alternating current with high frequency—can be used to weld practically all commercial metals. It can also be used for hardfacing operations.

The unit has an improved water-cooling system that allows uninterrupted service at full-rated capacity of 500 amps. without overheating. (Higher currents are possible with reduced duty cycles.) The cooling water flows into the torch body and down around the water jacket housing the gas cup. The return flow leaves the torch body through a plastic hose housing the power cable. All external plumbing has been eliminated which prevents leakage from accidental damage and allows more maneuverability. Water-cooling makes light-weight torch construction possible, and because the power cable is also water-cooled, it too, is lightweight and easy to handle.

The torch is readily disassembled and because all internal water flow passages are straight, cleaning is an easy matter even in hard water districts where lime deposits are usually a problem.

Quick release collets are another feature of the new torch. Only a quarter turn of the torch cap releases the electrode for replacement. All the electrode adjustments are made through the torch cap which prevents burned fingers from hot gas cups. Electrode stub loss is minimized because the electrode holder is down close to the arc. Standard ¼-in. and ⅛-in. collet bodies are furnished to hold collets ranging from .040 to ⅛ and ⅛ to ¼ in.

This Heliarc torch is for continuous, heavy-duty inert gas arc welding at 500 amp.

New Materials and Equipment *continued*

Extra fine glass fiber cloth will find use in the electrical industry.

Extra Fine Glass Fiber Cloth Now Available

Production of a new Fiberglas cloth has been announced by *Soule Mill,* New Bedford, Mass.

The cloth, which measures 0.001 in. in thickness, and weighs .81 ounces per sq yd, is made possible by using glass fiber yarns finer than any ever before produced. Commercial production of this fabric is the culmination of a year's joint research by Soule and *Owens-Corning Fiberglas Corp.*

Principal significance of the cloth is its applications in the electrical apparatus industry where, as the carrying medium for mica and insulating varnishes, it will permit design engineers to further reduce space factor requirements.

During the past ten years, use of glass fiber textile products has enabled designers to reduce the size of electrical apparatus of a given rating by as much as 40% with consequent savings in copper, steel and other components. Fiberglas yarns tolerance of high temperature and their inorganic nature have made possible also the appearance of an entirely new classification of electrical insulation, Class H, with standards of performance far above those of older classes.

In spite of its sheerness, 20 yards of fabric 36 in. wide are woven from one pound of glass yarn. The cloth is remarkably strong. This new Fiberglas fabric represents a reduction of 33-1/3% from 0.0015 in. glass cloth, the thinnest made until now.

Additional potential applications in the general plastic and film reinforcement fields are predicted for the new material.

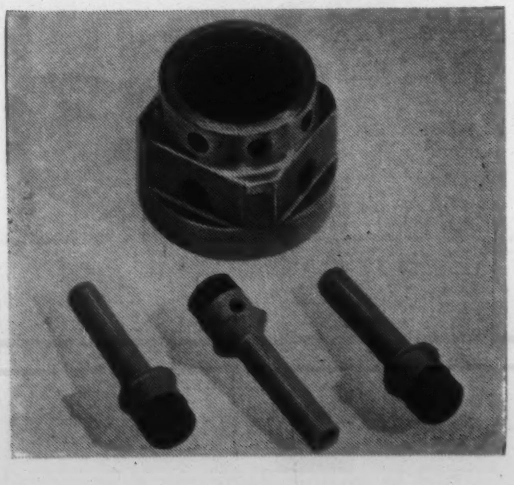
Coating for Electroplating Racks Cuts Maintenance Costs

Hanson-Van Winkle-Munning Co., Matawan, N. J., has announced a new coating for insulating and protecting racks, fixtures and anode hooks used in electroplating baths. Kote-Rax Grade L, a plastisol coating, was especially formulated to reduce maintenance costs.

Because it is tough and ductile, the Grade L coating will withstand rough treatment and abuse, and will wear longer both in and out of the bath. It has a dielectric strength of 600 v per 1 mil thickness at thicknesses of 20 to 25 thousandths of an inch; and a dielectric strength of 125 to 150 v per 1 mil thickness at thicknesses of up to $\frac{1}{8}$ in.

A smoother, more stable coating, it assures minimum drag-cut loss and retains its original color permanently. The original color is a light orange, which can be easily checked for aging defects. The new coating is resistant to all of the commonly-used cleaning, pickling and plating solutions.

For application, the only equipment required is a tank and a curing oven, both of which can be homemade. If the racks and fixtures are not too big, they may be dipped in the Kote-Rax drums. Before coating, a primer is applied to the racks. It is either brushed, dipped or sprayed on. The racks and fixtures are then heated to 350 F for 10 min. While still hot they are dipped into the coating until thoroughly cooled. Cooling usually takes from 2 to 5 min, depending upon the size of the racks. After cooling, the racks are placed in an oven and baked for 10 min at 350 F. If heavier insulation is desired, a second coat is applied in the same way; however the racks would be given a 15-min bake instead of a 10-min bake.



Rubber-to-metal bonded parts can be used in a wide range of temperatures.

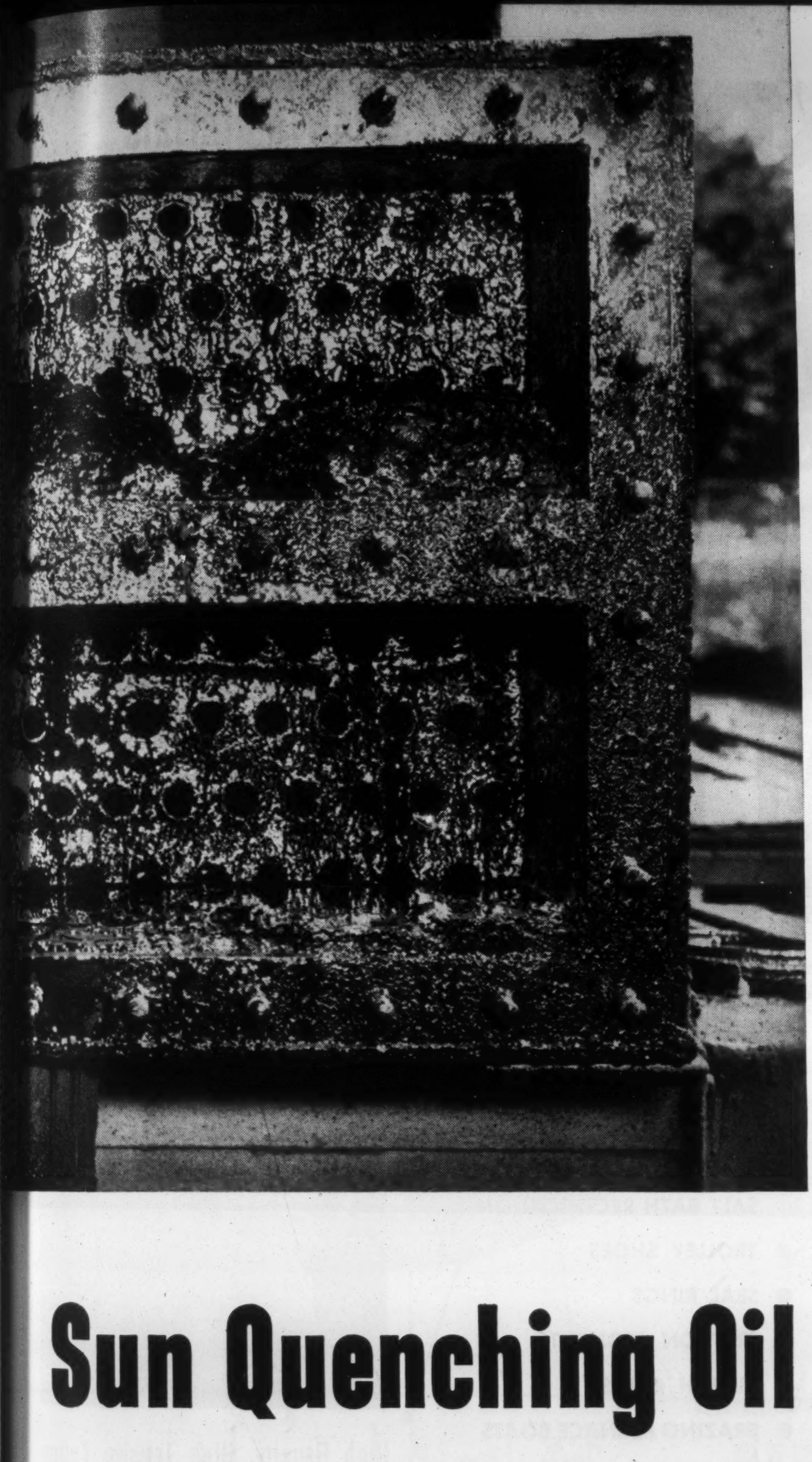
New Rubber-To-Metal Bonding Process

Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif., has introduced a new rubber-to-metal bonding process known as Permadizing. The new technique offers to designers a rubber-to-metal material whose dimensional tolerances can be held as closely as metal—as fine as a 5 micro-finish. The process is said to eliminate harmful flash and flaring of rubber and bonding agent on metal inserts, to minimize rejections and wasteful and costly rework. Permadizing successfully bonds aluminum to many varying compounds of rubber, synthetic rubber, or silicone.

The process is a high-production technique, giving consistent, variation-free results even over the longest runs. The bonded parts are available for operation in a wide range of temperatures, exhibit extremely low-swell, are highly resistant to aromatic fuels and hydraulic fluids, and have a steel-smooth finish. Parts can also be made successfully corrosion-resistant.

With Permadizing, designers may specify use of rubber-to-metal bonded parts under a wider range of temperature. The process is for this reason in line with the trend toward higher altitude operations of combat aircraft, with the extreme ranges of temperatures and pressures encountered.

(Continued on page 139)



Sun Quenching Oil

Sun Quenching Oils Reduce Operating Costs
Sun oils thin out when heated, drain off parts faster and more completely. Dragout is reduced to a minimum. They do not thicken up, and under normal operating conditions need never be replaced. For more information about Sun Quenching Oils, call your nearest Sun office or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. ML-8.

INDUSTRIAL PRODUCTS DEPARTMENT
SUN OIL COMPANY
SUNOCO ®

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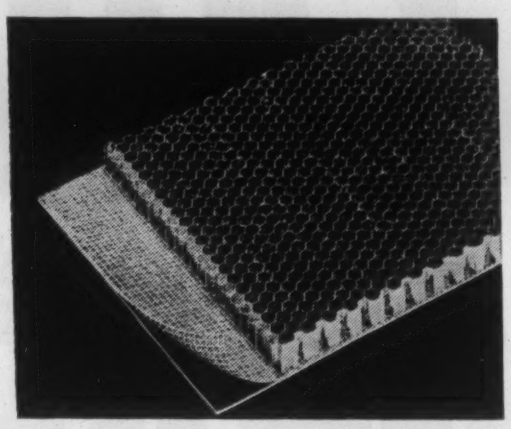
New Materials and Equipment



Glass Fabric Metal Bonding Tape

Coast Manufacturing and Supply Co., Box 71, Livermore, Calif., has announced production of a glass fabric supported metal bonding adhesive. This material was originally designed for joining aluminum surfaces and skins to honeycomb core in aircraft construction; however, it soon became apparent that the adhesive was extremely useful as a bonding agent for other surfaces as well, including the common ferrous and nonferrous alloys, plastics, glass, ceramics, woods, leather and textiles.

In appearance, Trevabond FM-47 is a film of translucent yellow resin reinforced by an open weave glass cloth. It comes in 3 coating weights; a light grade, having a total weight of 0.025 lb per sq ft; a medium grade, having a total weight of 0.035 lb per sq ft; a heavy grade, having a total weight of 0.060 lb per sq ft. The total thicknesses of these 3 films is 0.013, 0.022 and 0.030 in. respectively.

The mechanical properties of the heavy grade bonded joints are said to far exceed all values listed in the U. S. Air Force Specification for Metal to Metal Structural Adhesive, (U.S.A.F. Spec. #14164). The medium and the light grade films are suggested for less critical bonding requirements. Maximum bonding strength is realized with Trevabond FM-47 when the surfaces to be joined have been properly pre-treated. None of the pre-treatment measures are at all complex and consist essentially of a surface cleaning and conditioning process.

New Furan Plastic Finding Many Applications

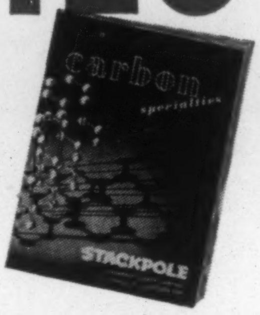
A new furane plastic has been finding extensive use in renovating wood and Masonite table tops and equipment. Jet-Kote, a dark colored furane resin, offered by *Furane Plastics, Inc.*, 4516 Brazil St.,

STACKPOLE

CARBON and GRAPHITE

SPECIALTIES

Get this helpful booklet! In addition to details on Stackpole products, this 44-page Booklet 40A includes helpful engineering discussions on the physical and electrical properties of carbon and graphite. Copy sent free on letterhead request.



- GRAPHITE TUBE ANODES
- BATTERY CARBONS
- GROUND RODS
- NON-WELDING ELECTRICAL CONTACTS
- VOLTAGE REGULATOR DISCS (carbon piles)
- WATER HEATER and PASTEURIZATION ELECTRODES
- BEARINGS
- WELDING RODS
- WELDING PLATES and PASTE
- RESISTANCE WELDING and BRAZING TIPS
- CHEMICAL CARBON and GRAPHITE (Plain or Treated)
- CARBON RODS FOR SALT BATH RECTIFICATION
- TROLLEY SHOES
- SEAL RINGS
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- ELECTRIC FURNACE HEATING ELEMENTS
- MOLDS and DIES
- CONTINUOUS CASTING DIES

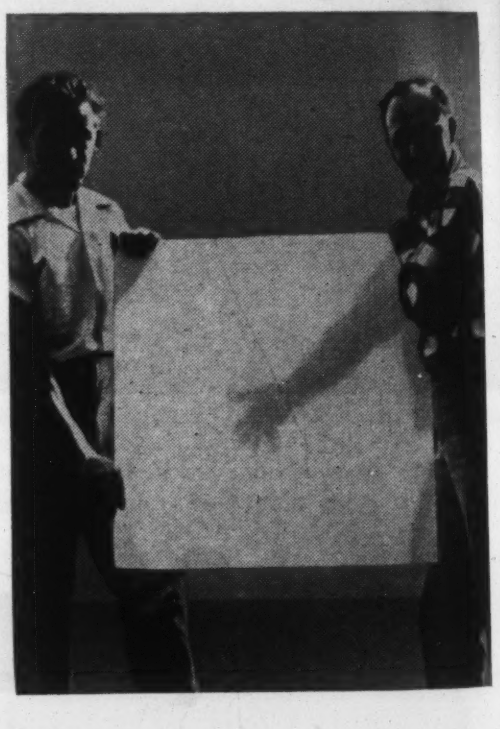
STACKPOLE CARBON COMPANY
St. Marys, Pa.

EVERYTHING IN CARBON BUT DIAMONDS

Los Angeles 39, will chemically set at room temperature, yet it possesses good heat and chemical resistance. These qualities have led to major applications in recent food processing plants, chemical plants, and metal working establishments.

Surfaces to be protected are either coated with Jet-Kote alone, or glass cloth is welded to the surface, affording a strong, heat resistant combination which will withstand severe mechanical abuse. What has appealed to plant engineers is the fact that this protection can be applied to old table tops or parts which have been worn excessively and are ready for replacement.

Where it is necessary to fill in large cracks, notches, bruises, or seams of tanks, a special activated silica filler is available to give sufficient body to Jet-Kote. In combination with the filler, Jet-Kote may be troweled into place.



High Density, High Tensile Teflon Sheets

The development of a new manufacturing technique by *Ethylene Chemical Corp.*, Summit, N. J., has made possible the offering of extremely low porosity, high density, high tensile and supersmooth Teflon sheets. Stress-relieved sheets are also made available.

These quality sheets of versatile Teflon are approximately 29 by 29 in. and are available in any thickness from 0.050 to 2 in.

The sheets are finding applications as gaskets, valve seats, diaphragms, and wherever high density and low porosity are important.

Stress relieved sheets are also available

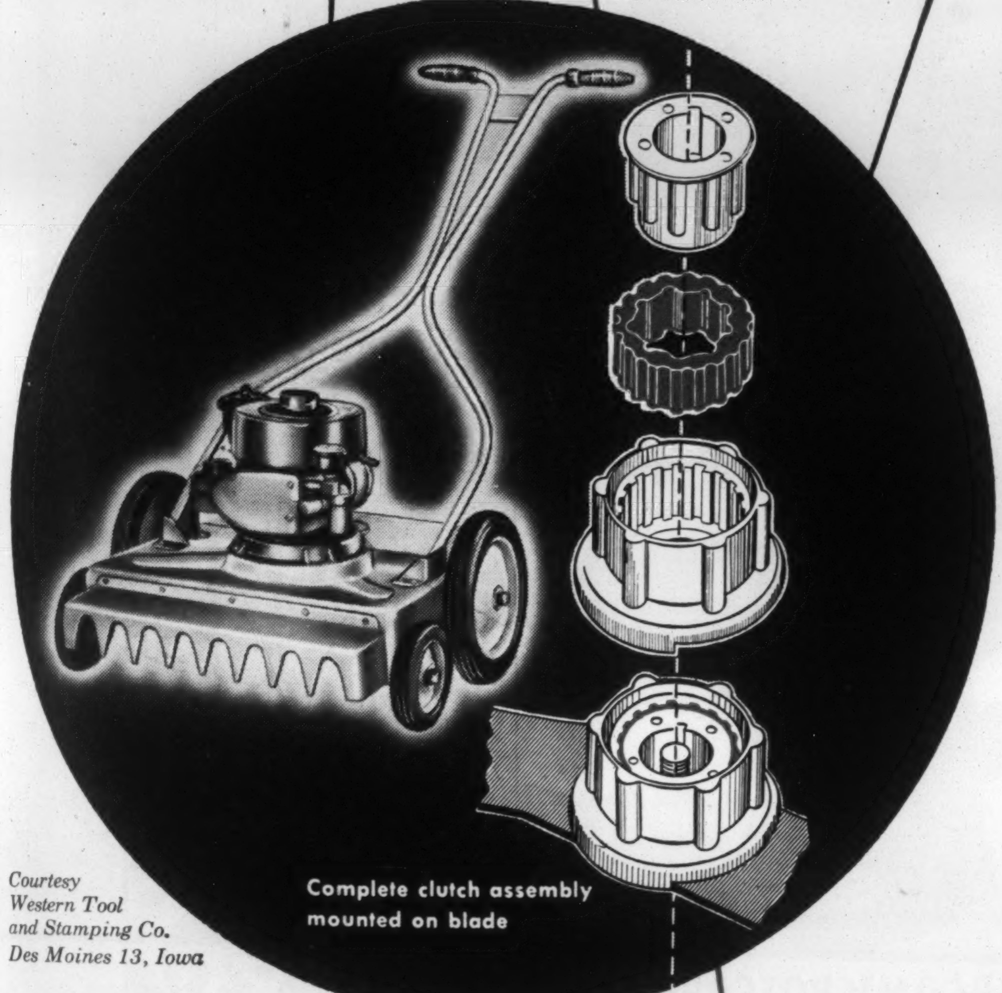
OIL RESISTANCE

ABRASION RESISTANCE

LOW COMPRESSION SET

These properties of neoprene make a better

ROTARY LAWNMOWER



Complete clutch assembly mounted on blade

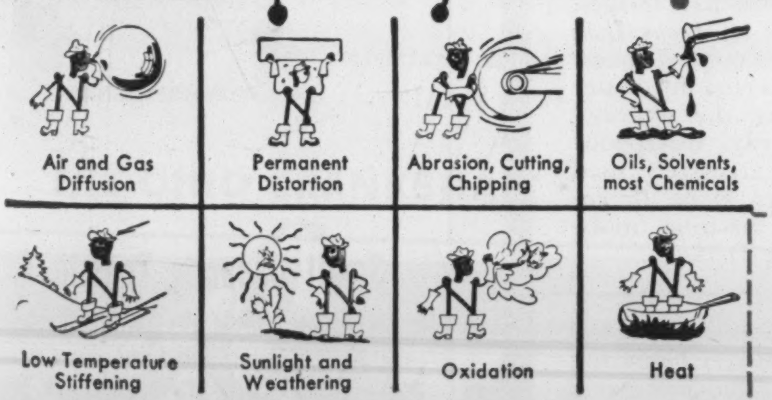
Courtesy Western Tool and Stamping Co. Des Moines 13, Iowa

Rough ground and solid objects are no threat to the blade and engine crankshaft of this lawnmower—thanks to a shock-absorbing clutch. It consists of a fluted neoprene ring set between two concentric metal sleeves. The inner sleeve is keyed to the crankshaft . . . the outer sleeve to the blade.

Should the blade strike an obstruction, the neoprene ring remains locked to the vertical serrations of the outer sleeve, while the inner sleeve and the crankshaft continue to rotate. The flutings on the inner sleeve are rounded, permitting them to squeeze past the resilient neoprene ring, deforming it and absorbing the shock. After the obstacle has been removed, the inner flutings re-engage the ring and automatically "reset" the clutch.

Neoprene was specified for this critical ring because it withstands severe abrasion and resists attack from lubricating oil. And its low compression set means this ring will retain its shape despite the constant pressure and shearing action of the sleeves. Here, as in so many cases, the remarkable properties of Du Pont neoprene help make a design successful—so successful that this clutch is being adopted by many other manufacturers.

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:


Air and Gas Diffusion
Permanent Distortion
Abrasion, Cutting, Chipping
Oils, Solvents, most Chemicals
Low Temperature Stiffening
Sunlight and Weathering
Oxidation
Heat

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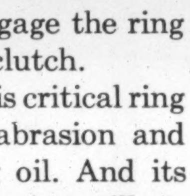
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

NEOPRENE

The rubber made by Du Pont since 1932

FREE! **THE NEOPRENE NOTEBOOK**



Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. The neoprene application cited above is covered in detail in Notebook No. 53. Add your name to the mailing list today.

E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Division MM-8, Wilmington 98, Del.

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Firm________________
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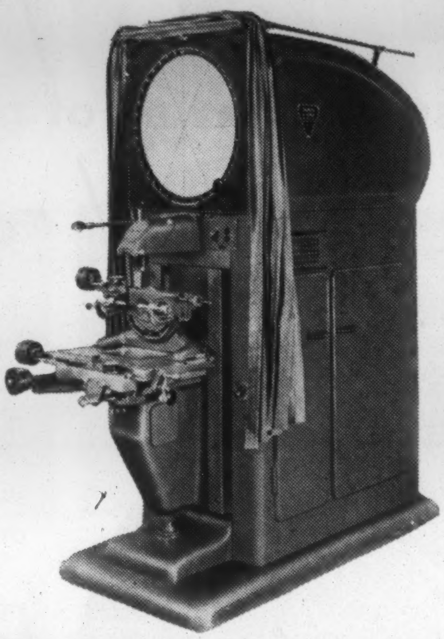
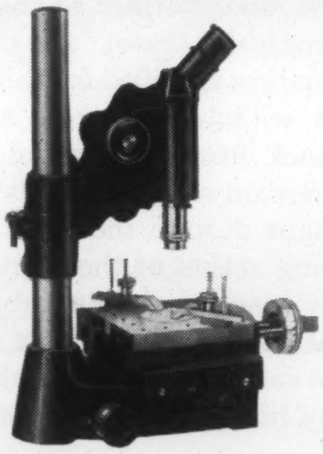
FOR *UNEQUALLED* PRECISION
in measurement, assembly, inspection . . .

CONTOUR MEASURING PROJECTOR

Save time, money, and materials by spotting inaccuracies quickly and simply . . . with highest-precision measurements. You get angular measurements to ± 1 minute of arc with a protractor screen, and direct linear measurements to ± .0001″ over a range of 4″ by 6″ with the cross slide stage. Dimensions, angles and profiles of production-run parts can be compared directly with a *traced* outline of the projected image of the master part, or with a scale drawing superimposed on the screen. Write for Catalog D-27.

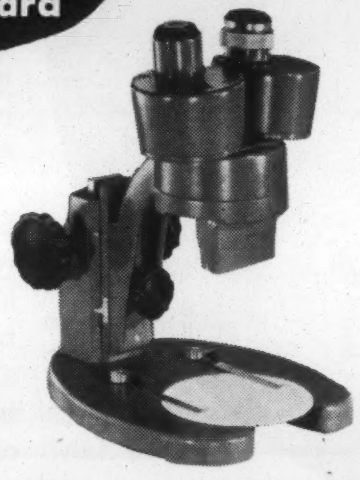


. . . industry's
UNEQUALLED standard



TOOLMAKERS' MICROSCOPE

This sturdy microscope gives you one inch linear measurements to ± .0001″ and angular measurements (with protractor eyepiece) to ± 1 minute of arc. Operation is extremely *simple* and *fast.* Opaque and transparent objects of any contour can be measured. Write for Catalog D-22.



STEREOMICROSCOPES

The finest optical system ever produced for stereoscopic work assures you precision accuracy in small parts assembly operations and in inspection of tools and finished parts. You get clear, sharp, three-dimensional images, and a *wider area of focus than ever before.* The magnified image is erect and *unreversed,* for easier interpretation by the average user. These sturdy, dustproof microscopes are extensively used in industry, either alone or incorporated into machine tools. Write for Catalog D-15.

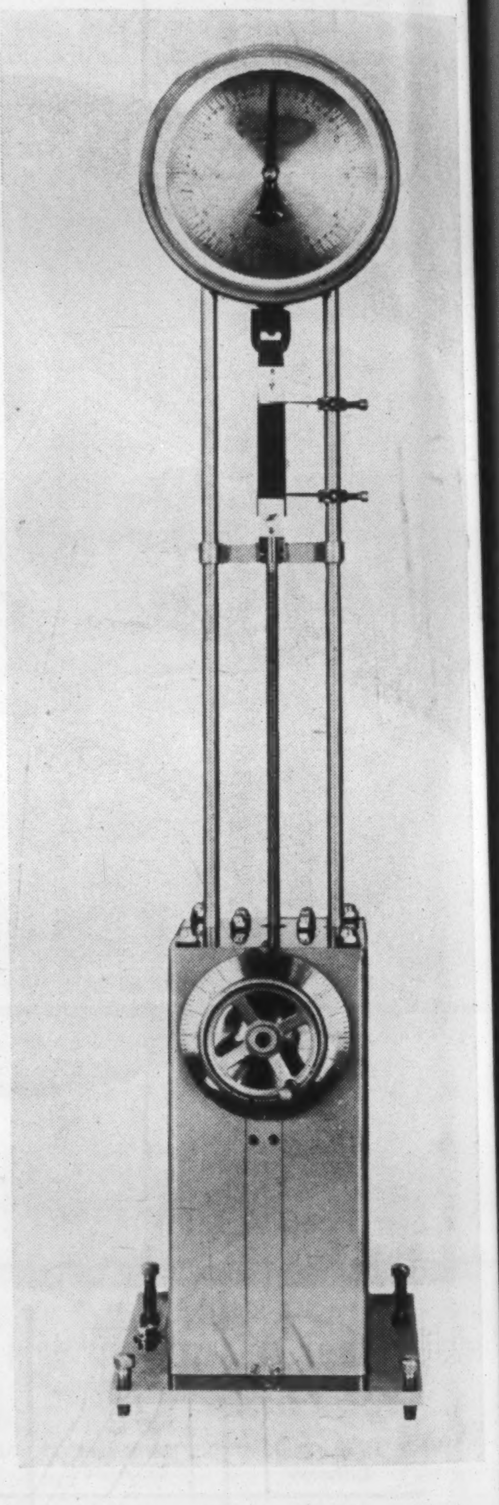
1853/1953
INTO A NEW CENTURY OF OPTICAL PROGRESS
BAUSCH & LOMB CENTENNIAL

WRITE for complete information on these efficient optical aids. You may be paying many times over their moderate cost in lost time and rejects. Bausch & Lomb Optical Co., 79320 St. Paul St., Rochester 2, N. Y.

Bausch & Lomb *Quality Control* Instruments

New Materials and Equipment

for applications where highest dimensional stability is required, particularly at high temperatures.



Small Capacity Tensile Tester

A newly developed small capacity tensile tester developed by *John Chatillon & Sons,* 85-93 Cliff St., New York 38, is designed to measure the tensile properties of fiber, cloth, cord, rubber and many other similar materials.

The unit is operated by means of a handwheel which is graduated to read extension in increments of 0.001 in. This handwheel drives a single thread worm

Another TOCCO® First!

INDUCTION HARDENED CYLINDER BORES...

for much longer
engine wear –
at much lower cost

PROBLEM:

Cylinder liners cost a lot of money, and, of course, they take up space that could be used for generating extra horsepower.

As a result engine builders, hoping to abolish the need for liners, experimented with various hard alloy irons that can furnish desired hardness in the cylinder bores.

However, these hard castings were extremely difficult to machine, and they cost several dollars per casting extra.

SOLUTION:

Now TOCCO® has developed and patented a process for Induction-hardening the cylinder bores of conventional, cylinder-iron castings. The blocks are easy to machine, yet cylinder bores are very hard to a depth of about 1/16″. This depth of hardness permits several re-honings with no loss of hardness in the cylinder bore.

The cost?—less than half the extra cost of alloy iron cylinder blocks.

This important development is typical of the way TOCCO works hand-in-glove with the Metal Working Industry to improve products and lower costs.

see our catalog in
MACHINE TOOL CATALOGS
or write for copy

THE OHIO CRANKSHAFT COMPANY

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JUST PUSH A BUTTON

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NEW **FREE** BULLETIN

THE OHIO CRANKSHAFT CO.
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Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating"

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how to put **your** product

in the

DAILY SWANS
NEWS!

with **NEW** **features**

NEW **advantages**

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Typical examples
of newsworthy
Hackney Parts

Check into the successful experience of other manufacturers who have put their products in the headlines by replacing a heavy cast, forged or welded pipe part with a lightweight Hackney seamless drawn part.

By specifying Hackney Deep Drawn Shapes and Shells, designers of many types of equipment have developed new quality standards . . . new strength and durability . . . new streamlined appearance . . . new seamless construction . . . new, lower unit costs . . . and other easier-to-sell advantages.

Write today for further information.

PRESSED STEEL TANK COMPANY

Manufacturer of Hackney Products

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Hackney
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CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

gear which automatically holds the tension at any given point. Tension load is read by a single pointer which will remain at the point of maximum load until it is manually reset to zero.

Standard capacities are available from 1 to 100 lb with the following graduations: 1 by 0.01 lb; 5 by 0.02 lb; 10 by 0.05 lb; 25 by 0.1 lb; 50 by 0.25 lb; and 100 by 0.25 lb. The dials range in diameter from 7¾ in. for the smaller capacities to 10 in. for the larger. (Metric graduations are also available within the range of the tester.)

New Surface Finish for Iron and Steel

Formula #50, a new method of surface protection of iron and steel, has been developed by the *Constad Laboratories*, 120 W. 28th St., New York 1. The recently developed product is described as offering the advantages of hot dip galvanizing without the need for dismantling.

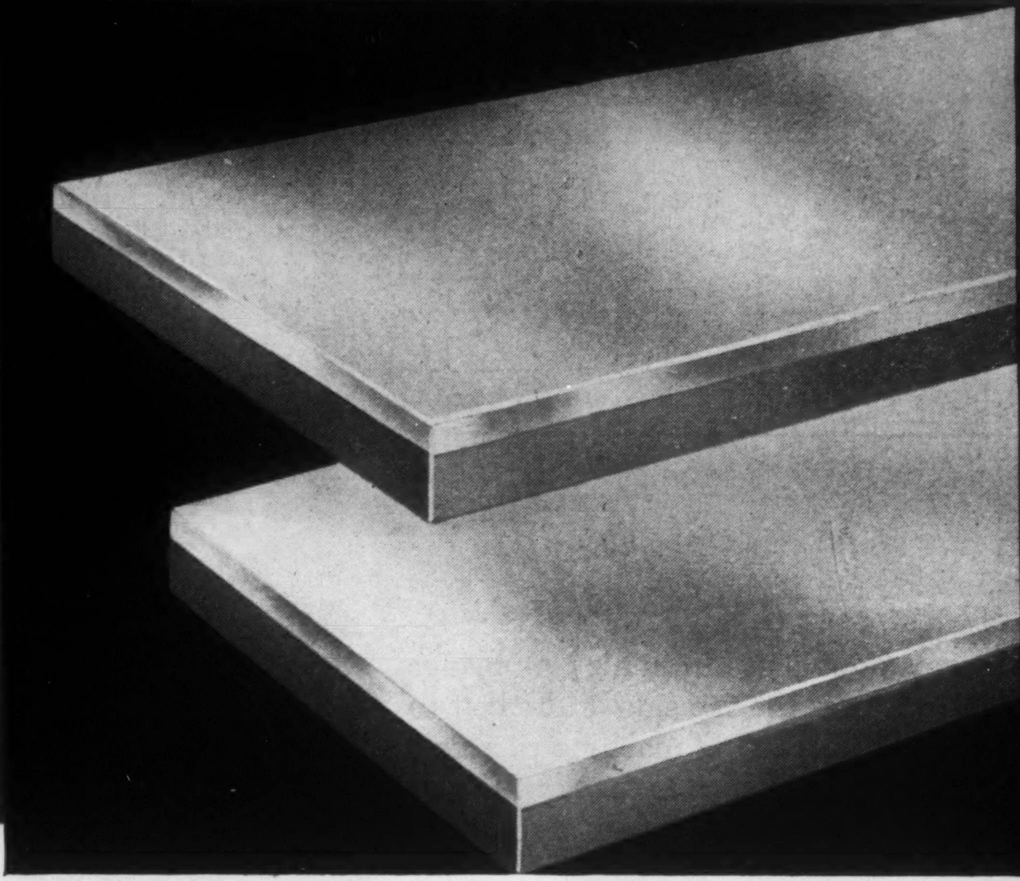
Applied easily with a paint brush or spray gun (60-90 lb. psi. with a number 4 nozzle) the formula takes only 1 hr to dry. At brushing consistency it leaves a deposit of 0.25 per sq ft; of a thickness of only 0.005 to 0.007 in. One gallon will cover 500 sq ft.

Magnesium Die Casting Ingot Offered

Dow Chemical Co., Midland, Mich., has announced the availability of a new magnesium alloy ingot patterned to the needs of the commercial magnesium die casting industry. This alloy, designated as Dowmetal AZ91B, contains beryllium additions for lower melt loss and increased efficiency.

The product differs from other types of metallic paints in that it can be used over rusted surfaces (loose scale removed) and that a galvanic action takes place through the rust, which is probably reduced to metallic iron (magnetite). Formula #50 produces electrical continuity between the steel and the coating, thus preventing rust creep. Widely diversified in its application, it can be used on any iron or steel surface whether new, old, CF&I

STAINLESS-CLAD PLATES



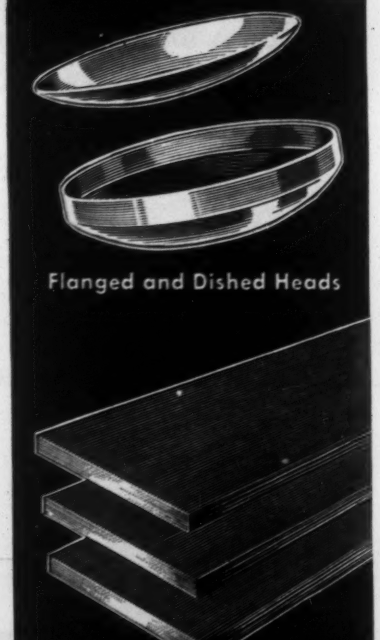
stainless steel advantages
. . . with carbon steel strength
. . . at lower cost

If you use stainless steel in your fabrication or construction, chances are you can lower your material costs substantially by means of Claymont Stainless-Clad Plates.

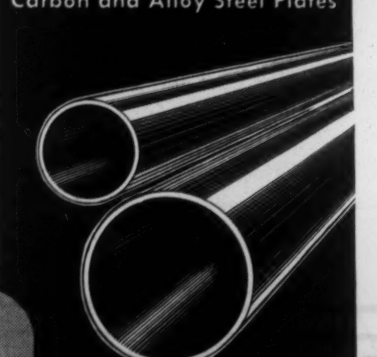
In numerous and diversified applications, these plates are giving all the advantages of stainless steel, including prolonged resistance to the corrosive action of acids and alkalis.

Claymont Stainless-Clad Plates are a composite of stainless steel permanently bonded to a carbon steel backing. Easy to fabricate, they will not buckle, crack or peel under the severest forming operations. To order, write or call Claymont Steel Products Department, Wickwire Spencer Steel Division, Claymont, Delaware.

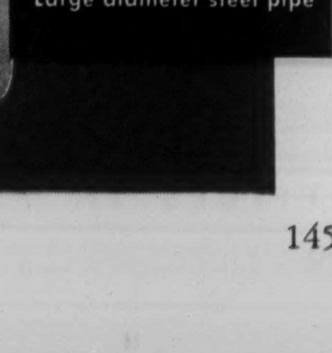
THE COLORADO FUEL AND IRON CORPORATION—Denver, Colorado
PACIFIC COAST DIVISION—Oakland, California
WICKWIRE SPENCER STEEL DIVISION—Atlanta • Boston • Buffalo • Chicago • Detroit
New Orleans • New York • Philadelphia
CANADIAN OFFICES: Toronto • Winnipeg • Edmonton • Vancouver



Flanged and Dished Heads



Carbon and Alloy Steel Plates

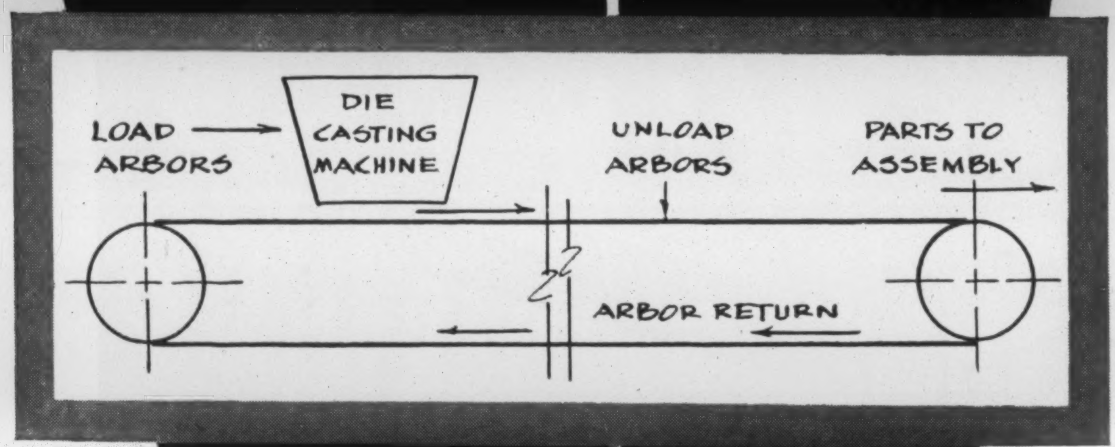


Large diameter steel pipe

CLAYMONT STEEL PRODUCTS
WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION CF&I

1280

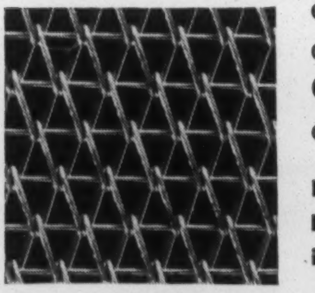
This CAMBRIDGE WIRE MESH BELT LEADS A DOUBLE LIFE



Here's a customer who gets double use from his Cambridge wire mesh conveyor belt. He uses the top side of the belt to carry loaded arbors from the diecasting machine . . . *uses the bottom side to carry empty arbors back to the machine for re-use.* Savings in equipment! Savings in floor space! Savings in handling and time!

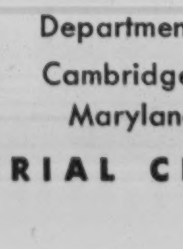
Room air circulates freely through the open mesh of the belt to cool the castings. Hot castings cannot harm the all-metal belt. The moving belt feeds parts to the subsequent assembly line at a constant rate of speed.

Even if you're not making diecastings, Cambridge wire mesh conveyor belts can help do many jobs in your plant . . . heat treating, brazing, sintering, pickling, quenching, to name just a few, They can be woven from any metal or alloy, thus can be used under even the most corrosive conditions. They can be fabricated in a wide variety of open or closed meshes, thus can be used for handling small or large parts. And, of course, Cambridge belts are made to any length or width.



HERE'S A TYPICAL CAMBRIDGE SPECIMEN . . . Rod-Reinforced. This particular weave is widely used in continuous heat treating furnaces.

For complete information on how Cambridge wire mesh belts can help you combine movement with processing, call in your Cambridge Field Engineer. He's listed under "Belting-Mechanical" in your classified telephone book. Or, write direct for this NEW, WIRE MESH BELT CATALOG. IT'S FREE! Gives conveyor and conveyor belt design and installation data, metallurgical tables, other useful information.



The Cambridge Wire Cloth Co.

WIRE CLOTH
METAL CONVEYOR BELTS
SPECIAL METAL FABRICATIONS

Department A
Cambridge 8,
Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

New Materials and Equipment

deteriorated, or as a touch up on previously galvanized surfaces. Sky lights, fencing, fire escapes and ladders, structural steel, pipes, ducts, gutters, leaders, storage tanks, towers, etc., are among recommended applications. Extensive tests in immersion, salt-spray, electrical continuity, bending, hiding power, abrasion and adhesion have been conducted by a leading testing laboratory and the reports are available from the company upon request.

High Temperature Vacuum Furnace

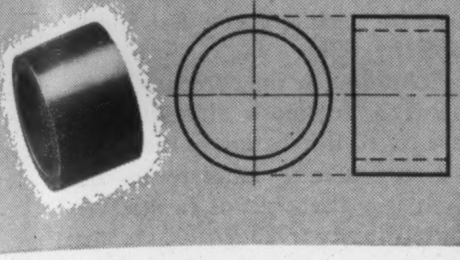
The *K. H. Huppert Co.*, 6830 S. Cottage Grove Ave., Chicago 37, has designed a new type high temperature electric vacuum furnace for production and laboratory use where temperatures up to 2500 F and vacuums up to 29 in. are required. Higher vacuum for special application can be supplied and furnace and vacuum system can be used independently of each other if desired.

The Airfre furnace is built in a large number of different sizes, and is complete with vacuum pump, and other necessary control equipment such as gages, automatic pressure controller, variac, ampere meter, timer, and automatic temperature controller completely wired for ready operation.

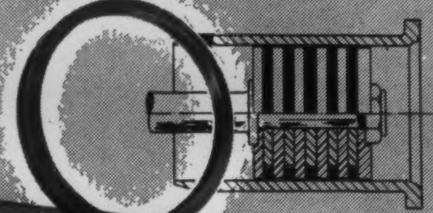
Protective Coating for Aluminum Offered

A new coating formulated for the protection of aluminum, stainless steel, and chromium, has been announced by *Silvercote Products, Inc.*, 161 E. Erie St., Chicago 11. Applied by either spray or brush, the coating has already successfully undergone a 1204 salt spray test (equivalent to

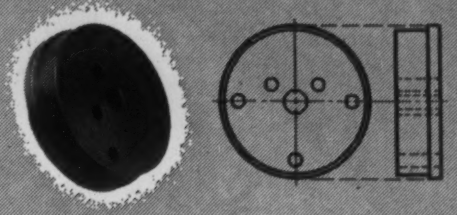
● **HIGH SPEED, HIGH TEMPERATURE SELF-LUBRICATING BEARINGS** — Applicable for pumps handling steam condensate at over 300° F at 300 PSI. Capable of withstanding high speeds and relatively heavy loading without conventional lubrication. Ideal for inaccessible locations.



● **SELF-LUBRICATING PRESSURE RINGS ELIMINATE OIL IN COMPRESSED AIR OR GAS STREAM** — Mechanically strong, chemically inert, impart no taste or odor. Eliminate contamination in food processing, and danger of explosion of combustible gases due to conventional lubricants.

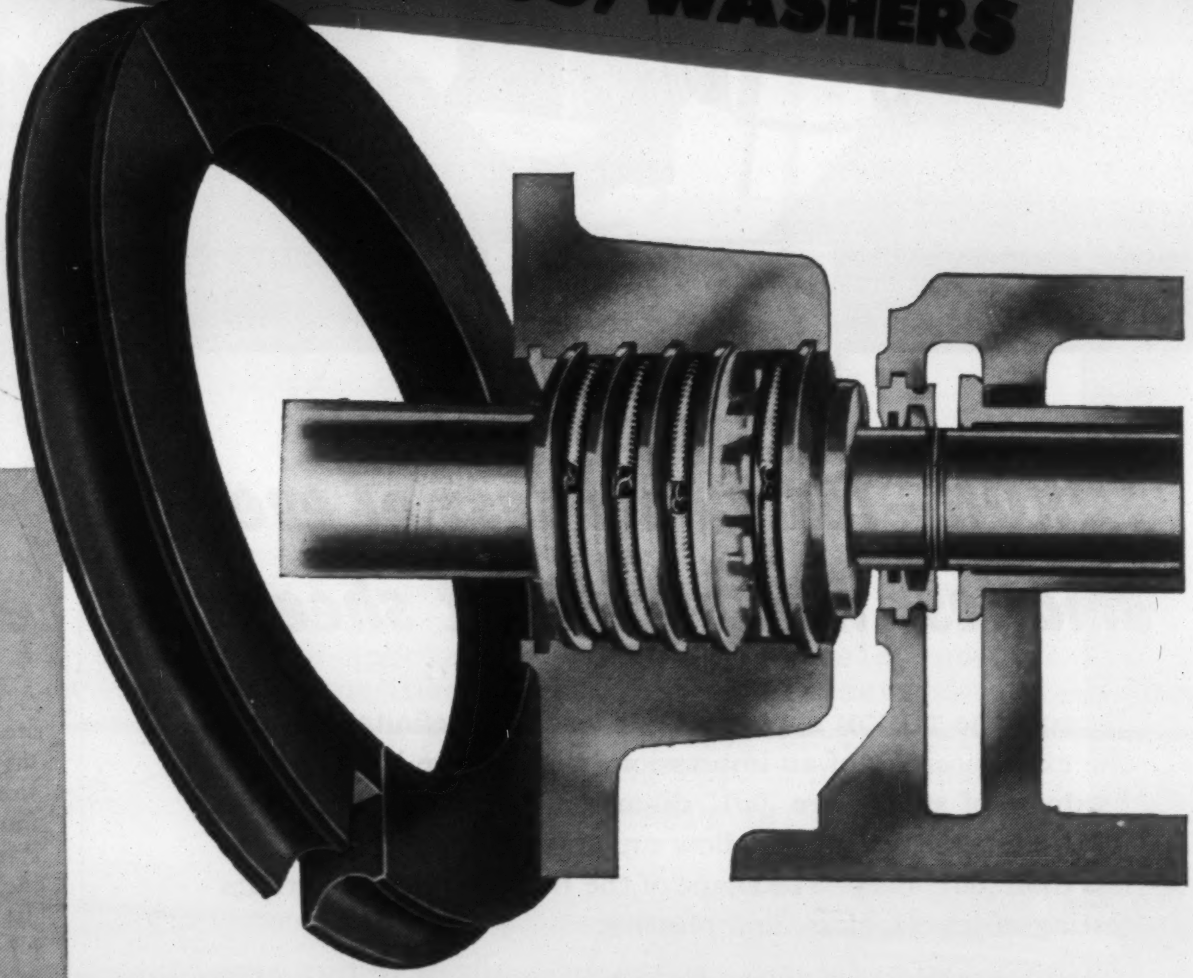


● **MORGANITE CARBON SEALS FOR HIGH PRESSURES AND HIGH SHAFT SPEEDS** — Mechanical seals withstand corrosive chemicals, grit, high shaft speeds. Seal highly volatile fluids under extreme pressures. Mechanically strong. Provide perfect sealing free of warping and gumming.



MORGANITE
HIGH PRESSURE
SEALS, RINGS, WASHERS

SELF-LUBRICATING
Turbine Seals



- **HOLD LIVE STEAM AT HIGH PRESSURE**
- **FUNCTION WITHOUT LUBRICATION**
- **RESIST CORROSION**

Inaccessibility is no factor because they have inherent self-lubricating qualities which last for the life of the seal. Full retention of steam from cold start to full load is assured. Specify Morganite Seals Rings and Washers for maximum operating efficiency and minimum shut-down time.

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FOR ADVICE ON YOUR HIGH PRESSURE SEALING PROBLEMS, SEND INQUIRIES TO —

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Morganite *INCORPORATED*

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MICROHARDNESS TESTING

TUKON—Tests hardness of even smallest wire, thinnest sheets

Because the TUKON applies a light load and definitely locates the exact position of an impression, you can use it to test the hardness of small wire .001″ diameter, thin metals less than .001″ diameter thick, or shallow superficially hardened surfaces less than .001″ deep. The shape of the Knoop Indenter permits testing of jewels, glass, and plastics.

TUKON Testers for micro and macro hardness testing were designed for researchers and scientists who require precision and repeated accuracy. Now, due to its advantageous design, it is finding its way into production control. Three models cover the range of diamond pyramid testing, both Knoop and 136 degree. All are complete, self-contained instruments. Each is carefully inspected and checked for accuracy and uniformity of readings by technicians in Wilson's Standardizing Laboratory.

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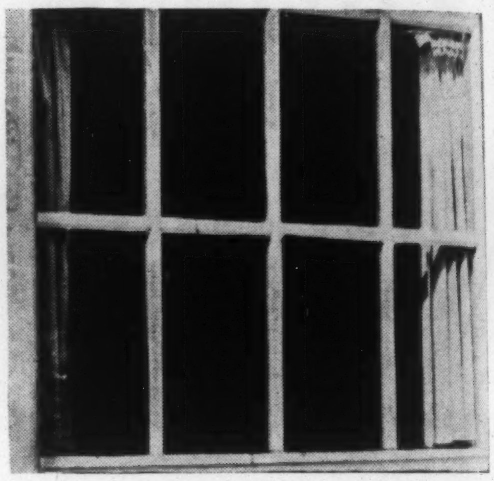
WILSON "ROCKWELL" and TUKON Hardness Testers

at least 5 years of outdoor exposure), a 3000 hr weatherometer test and a 100 hr humidity test.

According to the company, some of the country's foremost aluminum producers have tested the coating to their satisfaction, and commercial laboratories have also given it a clean bill of health.

Preparatory treatment of the metal prior to application of the new clear coating consists of only thorough soap and water cleaning. Once the coating is applied, it prevents oxidation of the metal surface. The coating will not discolor.



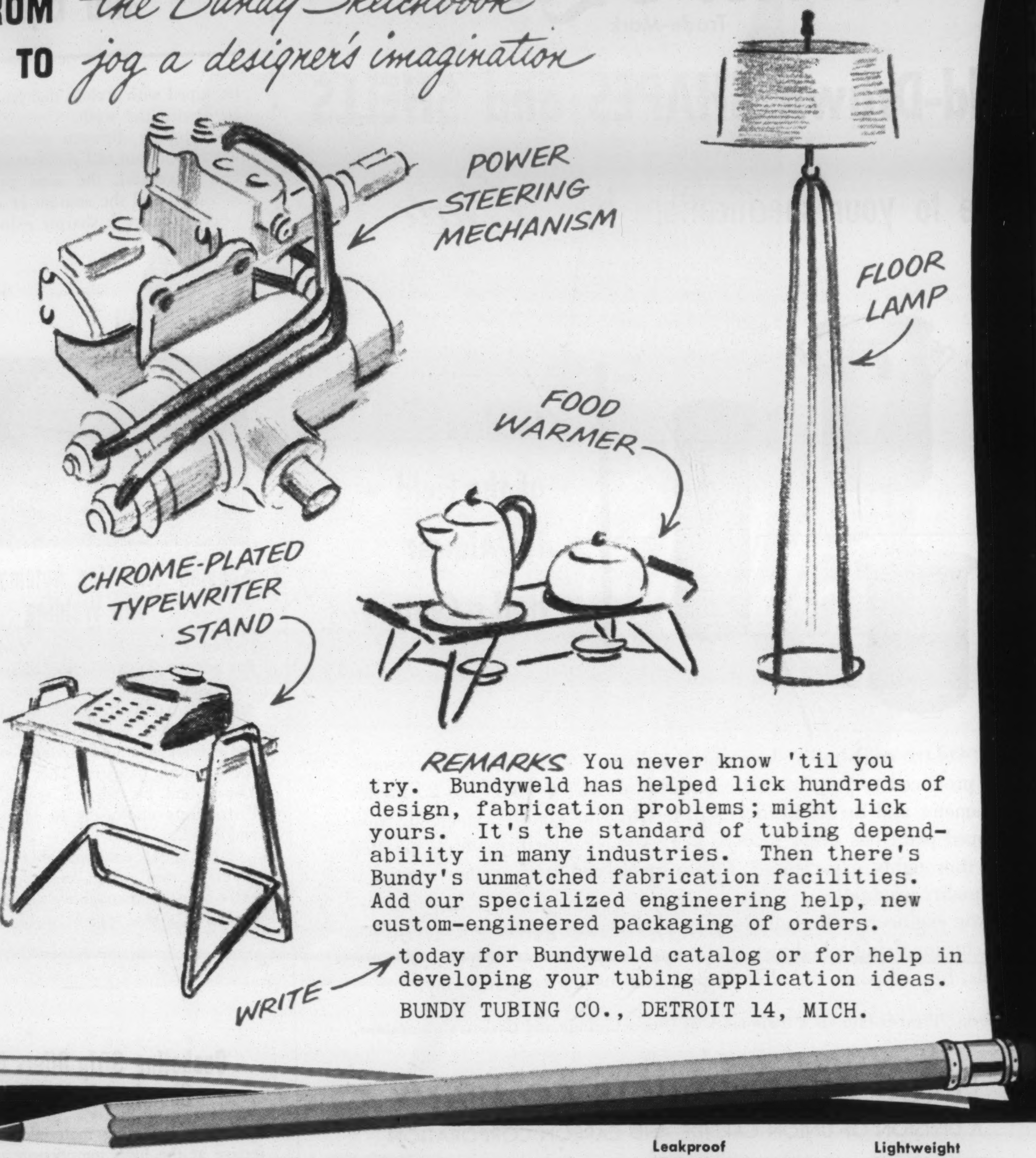
New Cleaners Cut Costs of Protecting Aluminum

Two new and easy-to-use products that are said to reduce by approximately 66% the cost of cleaning aluminum, stainless steel and chromium surfaces, have been introduced by *Lumin Sales Corp.,* 270 Park Ave., New York 17. In addition to cleaning, they also protect these metals from discoloration, oxidation, corrosion and pitting by providing an invisible coating against elements in the atmosphere that cause such deterioration.

Called Lumin Cleaner and Lumin Wash, they have been extensively tested and their use on aluminum has been approved and recommended by the Aluminum Co. of America, according to company statements.

Application procedure is extremely simple. If oxidation, discoloration or corrosion has already occurred, the cleaner must be used first to remove them. This is done by rubbing it on the metal surface, then washing it off with the wash. This wash leaves an invisible protective coating on the metal surface, and from then on, for permanent maintenance, it is necessary only to wipe the surface periodically with the wash. How frequently this should be done is dependent upon atmospheric conditions. (Normally 2 or 3 times a year is sufficient.) However, the company recommends that when the metal becomes dusty, it should

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



REMARKS You never know 'til you try. Bundyweld has helped lick hundreds of design, fabrication problems; might lick yours. It's the standard of tubing dependability in many industries. Then there's Bundy's unmatched fabrication facilities. Add our specialized engineering help, new custom-engineered packaging of orders.

WRITE today for Bundyweld catalog or for help in developing your tubing application ideas.

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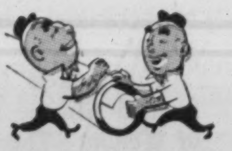
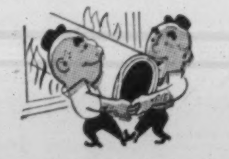
® DOUBLE-WALLED FROM A SINGLE STRIP

- Leakproof
- High thermal conductivity
- High bursting point
- High endurance limit
- Extra-strong
- Shock-resistant
- Ductile
- Lightweight
- Machines easily
- Takes plastic coating
- Scale-free
- Bright and clean
- No inside bead
- Uniform I.D., O.D.

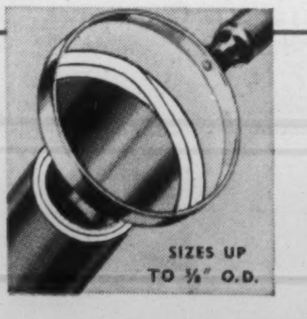
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .


continuously rolled twice around laterally into a tube of uniform thickness,


and passed through a furnace. Copper coating fuses with steel. Result . . .

SIZES UP TO 5/8 O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.



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NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

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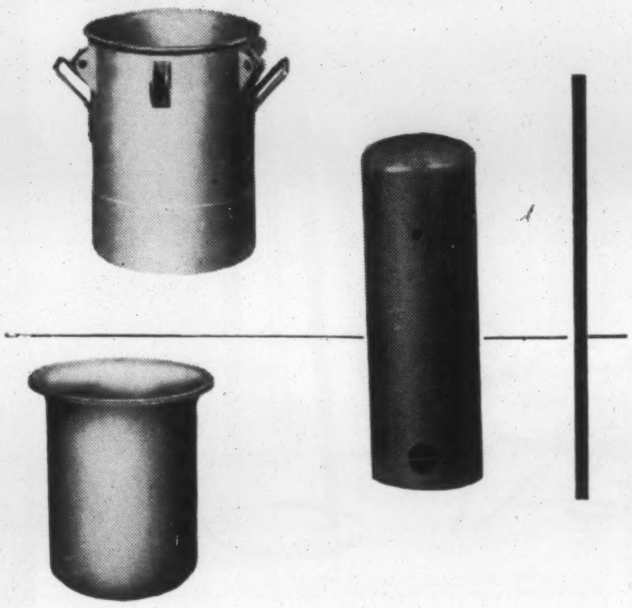
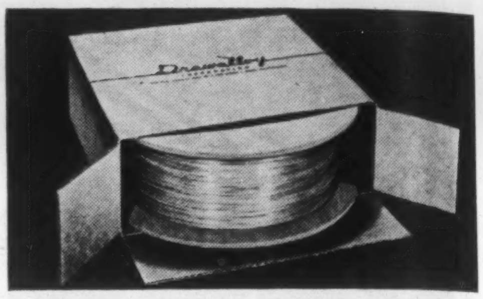


New Materials and Equipment

be wiped with a cloth that has been dampened with the wash.

A slightly different procedure is used with chromium and stainless steel surfaces, but in general, the same principles are followed, and the amount of maintenance work necessary is sharply reduced.



Spooled Wire for Automatic Inert Arc Welding

The Drawalloy Corp., York, Penna., has announced production of spooled wire for automatic inert arc welding. Spooled wire of 0.035 to 3/42 in. dia. in all stainless steel grades is manfactured to the special chemical analyses required by the welding industry. The wire is precision-wound on labeled spools, easy for distributors and users to identify, stock, and handle.

Each spool contains about 25 lb of stainless steel wire, and consists of an extra-heavy expendable plywood spool packed in a new type of sturdy carton.

Gasketing Strip Offers Heat, Chemical Resistance

A new gasketing material, equally effective at the high temperature of hot-air ovens for chemicals and the low temperatures of arctic regions or high-altitude flying, has been developed by *Joclin Manufacturing Co.,* 2964 Whitney Ave., Hamden, Conn. Called Fluorlastic gaskets, they combine the chemical resistance of Du Pont Teflon tetrafluoroethylene resin with the resilience and flexibility of silicone rubber. Their properties are unaffected by temperatures ranging from—130 F to 392 F.

The gaskets consist of long strips of foamed silicone rubber wrapped in sheets of Teflon. These are formed to permit edges of the sheeted Teflon to extend laterally beyond on one side of the silicone core. The edges are then heat-sealed to form an impenetrable envelope around the resilient core material. The resulting gas-

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You can obtain custom-cut felt parts from American, ready for assembly without further processing. Gaskets, washers, seals, wicks, discs—any shape you need, simple or complicated, can be turned out by us on high-speed machines, with tolerances to meet your specifications.

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5 OUTSTANDING PROPERTIES ... of STAR PORCELAIN

to help make more friends for your products ....

DIELECTRIC STRENGTH

When you are up against high voltage applications, count on STAR VITROLAIN with a dielectric strength of 106 volts/mil. and a dielectric constant of 6.6 (frequency of 1 megacycle). Far superior to commercial grade porcelain.

HEAT RESISTANCE

Many applications call for full insulating efficiency at elevated temperatures. STAR LAVOLAIN withstands exceedingly high operating temperatures and finds wide use as hooks, rods, bushings and other small parts in heating devices.

THERMAL SHOCK RESISTANCE

A refractory porcelain must be tough to resist sudden thermal changes as well as mechanical shock. STAR THERMOLAIN is made to meet the extreme conditions encountered in electric ranges, broilers, rheostats and similar applications. Available in many standard shapes.

MECHANICAL STRENGTH

For a porcelain to resist heavy impact, vibration abrasion and crushing, look to STAR VITROLAIN. It has flexural strength of 6760 inch/lbs and compressive strength of 67,300 lbs/sq/in. Investigate this formula for applications involving heavy usage and abuse.

MOISTURE RESISTANCE

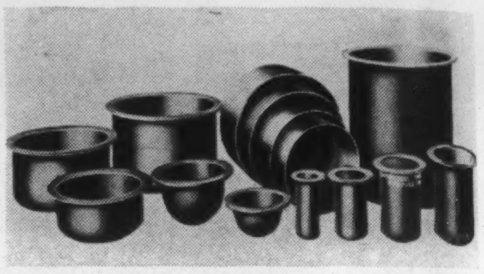
For effective insulation in outdoor applications and under conditions of high humidity, STAR VITROLAIN can be made with an absorption factor of 0.25%. Especially adapted for radio, telephone, railroad signal and similar applications.

These and other desirable properties are combined in varying degrees in the many other STAR porcelain formulae. Consult STAR Ceramic Engineers for help in the selection of the proper porcelain for your particular product.

Star PORCELAIN COMPANY
39 Muirhead Avenue • Trenton 9, N. J.

ket, which looks rather like weather stripping, is intended for use in chemical, pharmaceutical, and aircraft industries.

Because both Teflon and silicone rubber are unaffected by temperature over a wide range, it is expected that this gasketing material will find many applications by oven and autoclave manufacturers.



Pressed Steel Pots for Heat Treating

"Metalized" pressed steel pots for heat treating furnaces have been introduced by *Eclipse Fuel Engineering Co.,* Rockford, Ill. They are claimed to give up to 200% longer life than ordinary pressed steel containers.

The new pots are being manufactured with three different types of metalized coatings for temperatures up to 1500 F. from 1500 to 1700 F and for 1700 F and over.

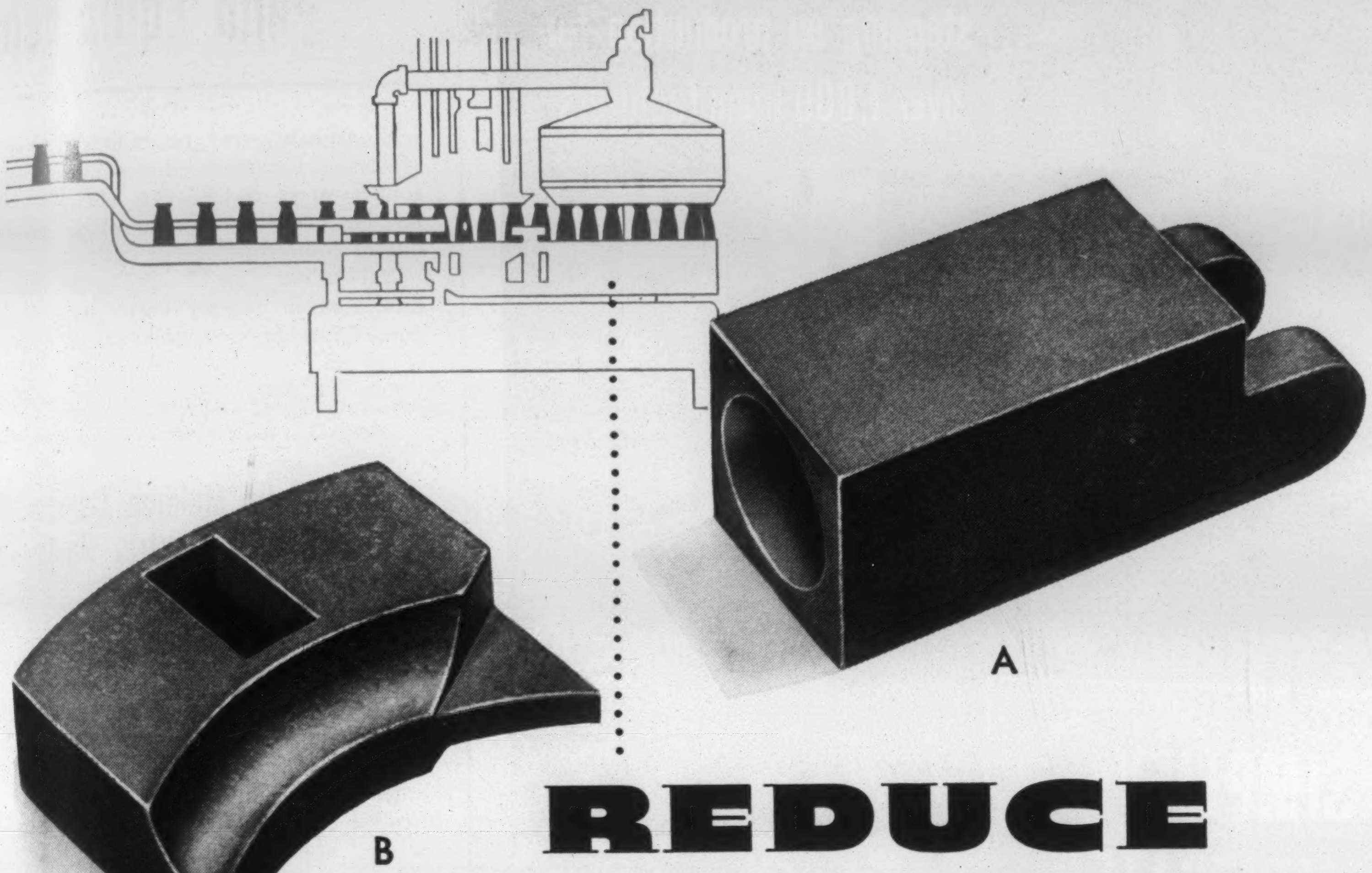
The resistant coatings are said to protect the pressed steel surfaces against heat oxidation and sealing otherwise caused by hot gases encountered in high temperature heat treating. All standard sizes are available.

Primer Improves Adhesion of Plastic Tape

A new polar, synthetic rubber-resin adhesive compound for use as a primer in the application of plastic tapes has been introduced by *Royston Laboratories, Inc.,* Blawnox, Penna. The primer, Roybond A-36, is said to increase adhesion of plastic tapes to pipe by 200%.

Roybond A-36 is plasticized with a special compound which blends with and absorbs the pressure-sensitive adhesive of plastic tapes. The bond between tape and primer improves with time as this plasticizer blends at the interface.

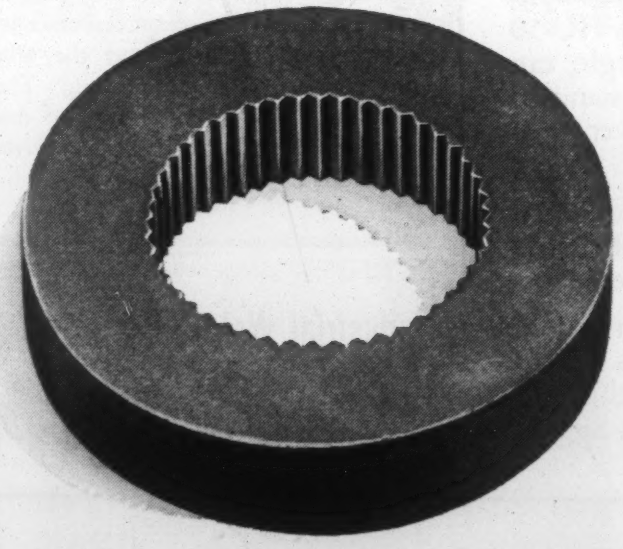
The primer possesses extreme wetting properties and displaces entrapped air and moisture at metal surfaces. It is compatible



REDUCE

costly machining time and extend product life

with Crucible ACCUMET Precision Investment Castings



C

Where parts are intricate or machining difficult, substantial savings can be made by using Crucible Accumet Precision Investment Castings.

The Type 303 Stainless castings shown above (A & B), for example, eliminated practically all expensive machining operations for a manufacturer of milk bottling machinery.

In many cases life of component parts can be greatly extended by using castings of high-alloy grades impractical to machine. The ring illustrated (casting C), used in a fine wire feed mill, is an investment casting made of Crucible *Rexalloy*, a non-ferrous cobalt-chromium-tungsten alloy steel providing exceptional wear and abrasion resistance.

Crucible engineers and metallurgists are available to help you solve design problems or lower production costs with Accumet Precision Investment Castings. Write now for further information.

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53 *years of* *Fine* *steelmaking*

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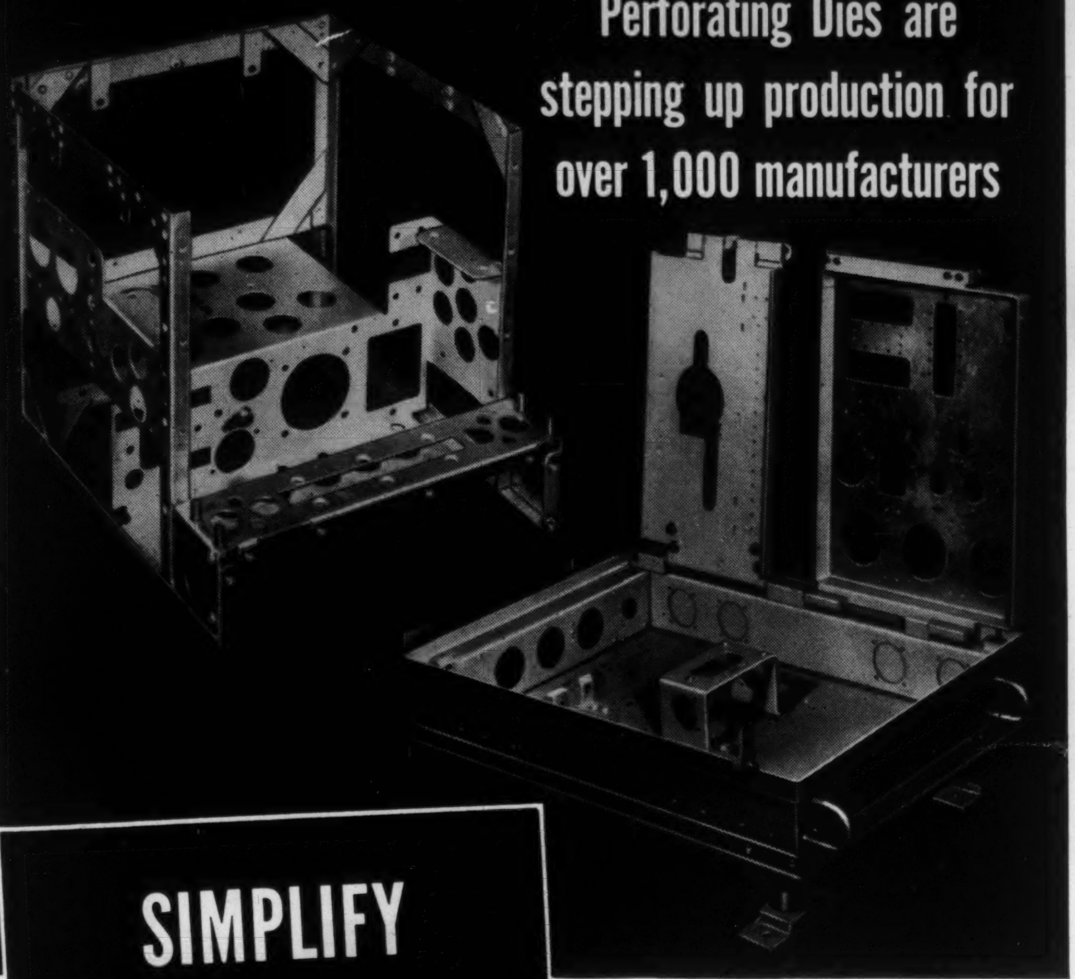
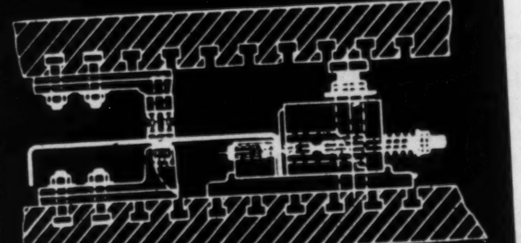
CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • ALLOY • MAX-EL MACHINERY • SPECIAL PURPOSE STEELS

Whistler Adjustable and Magnetic Perforating Dies are stepping up production for over 1,000 manufacturers



SIMPLIFY COMPLICATED PIERCING OPERATIONS



Use this HU-50 90° Perforating Unit on the same job with other Whistler Dies ... often saves extra press operations.

USE WHISTLER Adjustable and Magnetic Dies for perforating, notching and slotting sheet metals ... fast, accurate and cost cutting. Complicated patterns can be set up quickly. Hole arrangements can be changed in the press...without waiting and at no extra cost. New HU-50 units, that pierce at 90° angle, can be used in conjunction with standard perforating equipment. Fewer press operations are necessary.

Re-use the same dies in different arrangements on many jobs. Punches and dies are interchangeable.

Whistler Adjustable Dies can be used in practically every type press. Standard sizes and shapes of punches and dies available up to 3 inches. Special sizes and shapes to order.

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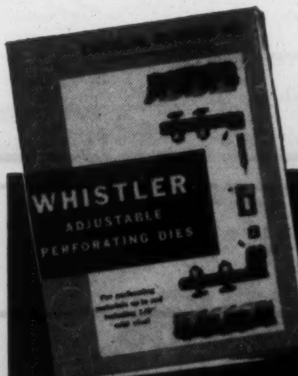
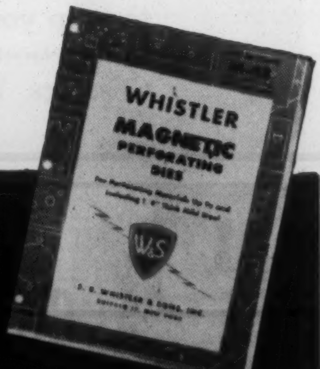


For prices and application data on this modern way to speed production and cut unit costs, write for these illustrated Whistler catalogs.



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New Materials and Equipment

with asphalts, coal tar, and rubber-type synthetics. Compounded to withstand high temperatures, it acts as an effective coal-tar, hot-enamel primer absorbing stresses due to contracture of hot enamel.

The primer can be applied by brush, flow coat or regular lacquer-type spray gun. Coverage is approximately 350 sq ft per gal.

New Phenolic Molding Compound for High Dielectric Parts

A new mineral-filled phenolic molding compound, Durez 16274 Natural, for molding parts requiring high dielectric properties, has just been made available by *Durez Plastics & Chemicals, Inc.*, North Tonawanda, N. Y. This material is said to have a low dissipation factor and low water absorption qualities. It is recommended by the manufacturer for parts to be used where conditions require long exposure to high humidity. It is claimed that its electrical properties are maintained even after immersion in water for long periods of time.

Durez 16274 Natural was formulated to obtain better molding characteristics, such as faster cure and longer flow, than existing compounds. It is available in two plasticities; one recommended for compression molding and the other for plunger or transfer molding. The new compound is also designed to meet the requirements of MIL-P-14 specification, Type MFE.

Industrial Welder Has Wide Range of Current Adjustments

To meet the requirements for a compact 50 per cent duty cycle welder with an unusually wide range of current adjustments, a new moving coil transformer type industrial welder has been developed by *Miller Electric Manufacturing Co.*, Appleton, Wis. Designated as Model 99, it has a rated output of 250 amp at 30 arc volts with a top usable output of 350 amp.

Its two open circuit volts, on different ranges, make it flexible in all applications with the higher open current voltage satisfactory for utilization of low-hydrogen electrodes. A new compact design that uses air spaced primary and secondary coils wound with high quality double glass covered insulated wire, is said to assure trouble-free, long life. Time-proved, continuous current control, using the moving coil principle, produces a smooth easy-to-handle flexible welding arc. Operation from either 220 v or 440 v, 60 cycle, single phase lines is standard.

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in selective surface hardening

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Frederick V. Geier, President, in formally dedicating the new **Flamatic Heat Engineering Building,** emphasized the long-range importance of this latest advance in the continuing progress of Flamatic Selective Surface Hardening.

Many activities will be carried on in this spacious new building . . . long range heat engineering and development work, special burner and tooling projects, experimental tests on customer's parts, final run-off and inspection of completed Flamatics. A complete chemical and metallurgical laboratory and a fully equipped machine shop are also provided.

This major investment in Flamatic progress combined with the skills of an experienced sales and engineering staff, and the use of modern manufacturing facilities, can yield important dividends for you in terms of better parts, at lower cost. Investigate Flamatic application to your surface hardening operations.

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Aluminum or Stainless Steel

New Test for Drawability

by C. B. BUKER AND J. R. SPEER,

General Technical Dept., Jones & Laughlin Steel Corp.

This quick and simple method overcomes the limitations of conventional hardness and cup ductility tests.

● The two most desired characteristics of sheet and strip steels are good drawability and freedom from stretcher strains. The usual means for estimating drawability is by hardness and cup ductility tests. Evaluation of stretcher strain has required a tensile specimen from which yield behavior is studied.

Conventional Tests Unsatisfactory

Both procedures leave a great deal to be desired in production line testing where volume, convenience and speed are most essential. They are generally time-consuming, destructive in character and extremely localized as to test result. Due to aging, the test result is often not indicative of the quality of the material at the time of its use.

The common practice of press and die men to bend the corner of a sheet to "feel" its resistance is at best only qualitative.

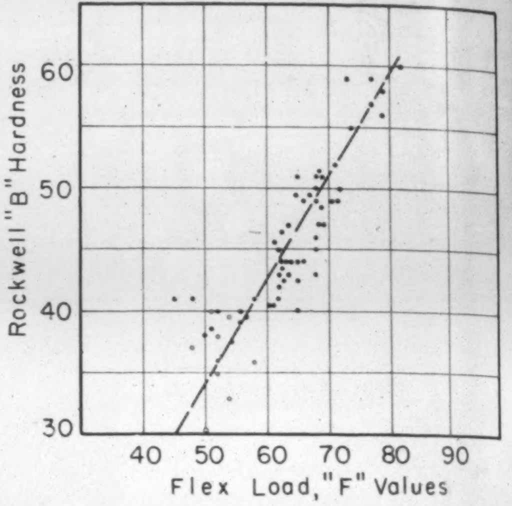
To overcome the limitations of these time-honored methods, a test has been developed which accurately measures the resistance of a material to a given bending force and which determines the degree of curvature of the bend produced. A small instrument, called a "Flex-Tester", is used to bend a corner of the sheet through a given arc. The resistance of the material to the bending force causes a projecting tongue portion, acting as a cantilever spring, to deflect. The deflection is recorded on a dial gage in what is arbitrarily termed "F" units.

Thickness Correction

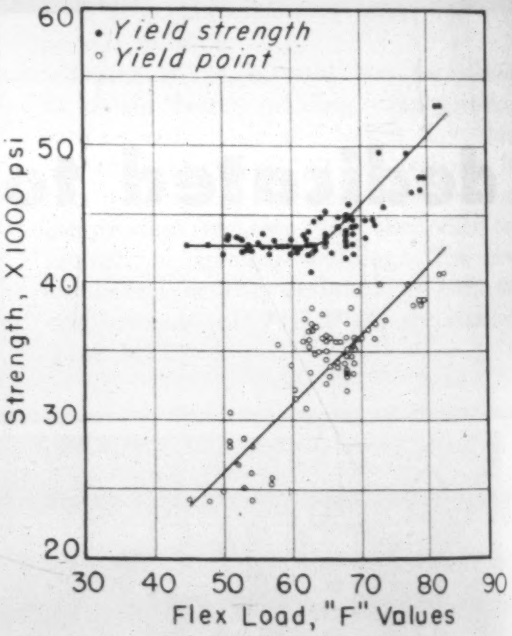
In order to obtain comparative "F" values, a correction for sheet thickness is required. A thickness of 0.035 in. was chosen as standard and the correction found most suitable was:

$$\text{"F" Value} = \left(\frac{0.035 \text{ in.}}{\text{actual thickness}}\right)^2 \times (\text{"F" units from dial})$$

The maximum curvature of the flexed corner is measured by a specially designed spherometer. These dial units have been arbitrarily termed "R" values.



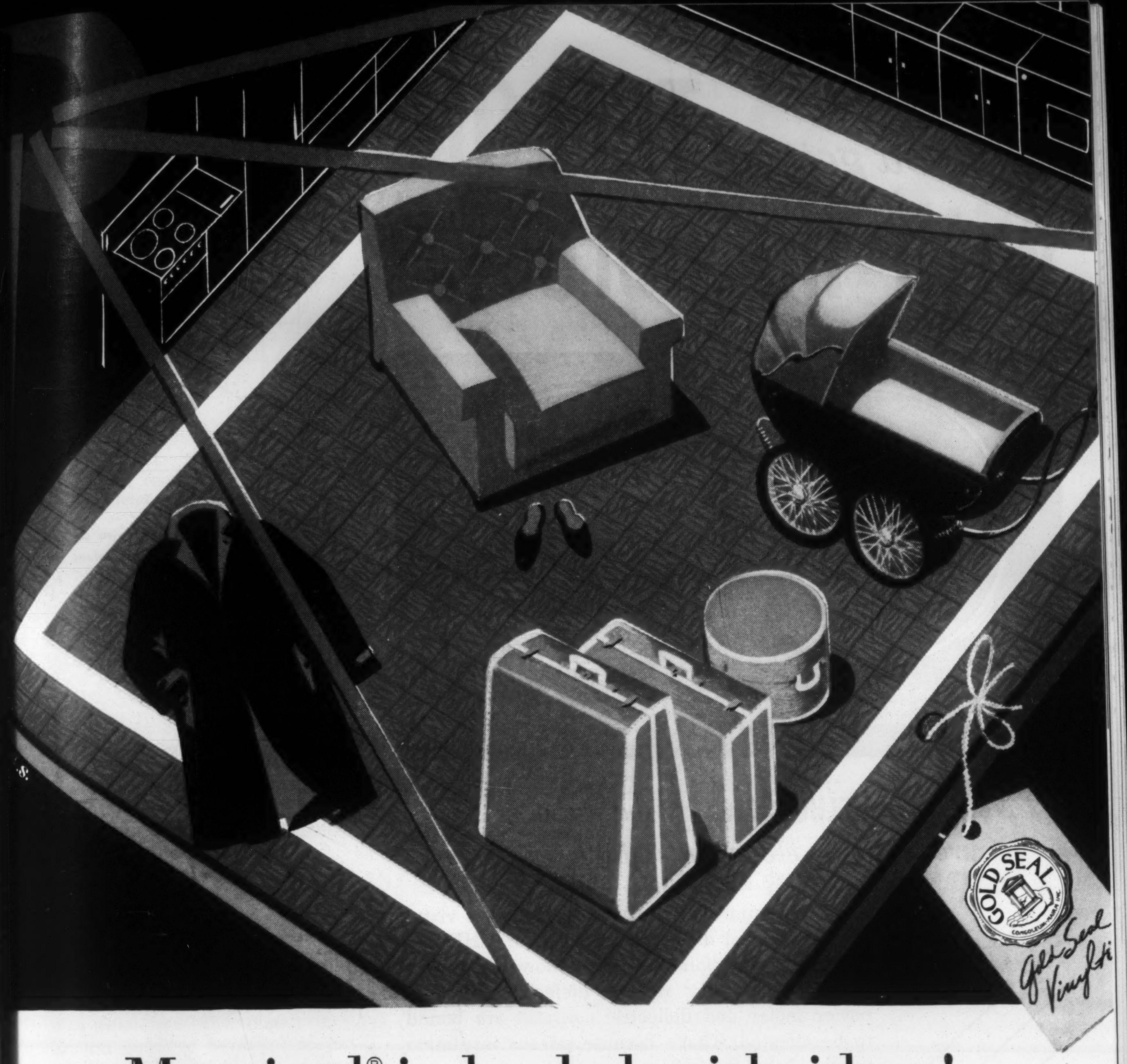
Relationship between hardness and flex load.



Relationship between tensile properties and flex load.

After evaluating the test in several different applications, the authors offered the following conclusions and recommendations:

1. The test requires no specimen preparation and can therefore be applied to raw material.
2. It is a simple, convenient and non-destructive test.
3. The "R" values provide manufacturers with the first production test to determine stretcher strain characteristics.



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Think of the beating your floor has to take!

Congoleum-Nairn, largest manufacturers of floor and wall coverings in the nation, thought of it. And they use Marvinol vinyl for their Gold Seal VinylTile*. Why?

More lasting! Tough, flexible, resilient tiles made with Marvinol wear and wear—won't dry out, crack, pucker, or shrink, even exposed to a wide temperature range.

More beautiful! Marvinol can be given any *built-in* color or shade—beauty that *can't wear off,* won't fade in the strongest sunlight.

More practical! These tiles never need waxing for protection against wear! They resist scuffing, dirt, stains, grease, acids, and other common kitchen chemicals—come clean with a damp mop.

Marvinol can be extruded, calendered, molded, or laminated, formed into an amazingly wide variety of end products, including raincoats and shower curtains, shoe soles and welting, upholstery, wall and floor coverings, luggage, and chemical-resistant pipe.

Our sales engineers will be glad to talk over your specific product problems with you. For more about this partner to Naugatuck's VIBRIN® polyesters and KRALASTIC® rubber-resin blends, write on your company letterhead to the address below.

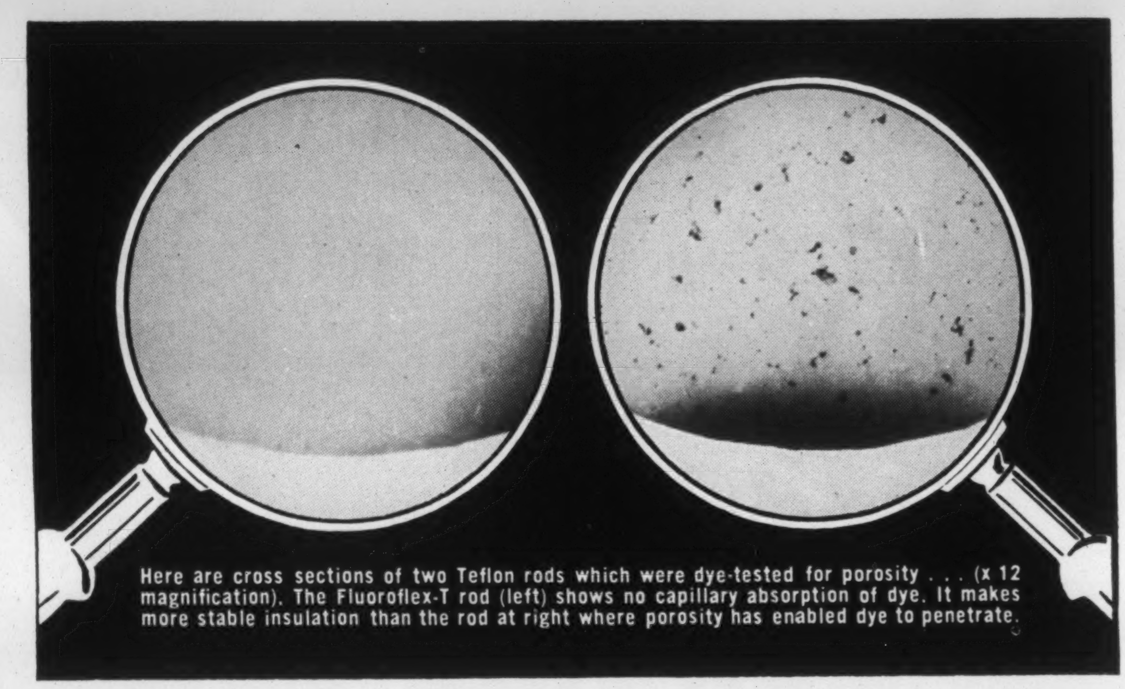
*Gold Seal VinylTile® by Congoleum-Nairn Inc., Kearny, N. J.

Naugatuck Chemical

NAUGATUCK, CONNECTICUT

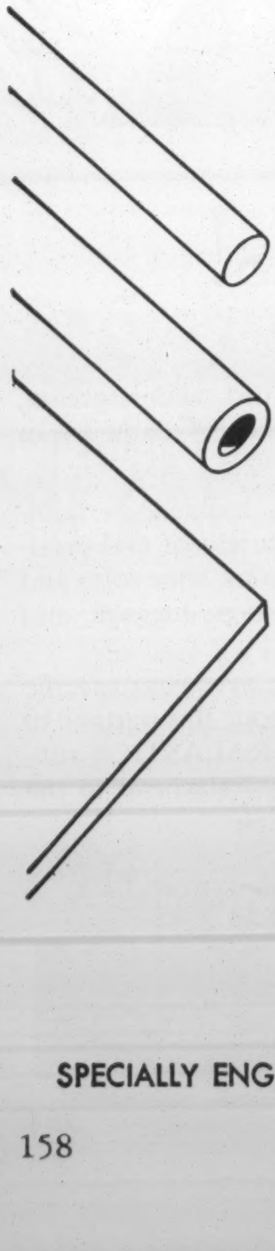
Division of **UNITED STATES RUBBER COMPANY** • 18 Elm Street, Naugatuck, Conn.
BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis
New York • Philadelphia **IN CANADA:** Naugatuck Chemicals, Elmira, Ontario

Are you getting **TEFLON*** **with no porosity**



Here are cross sections of two Teflon rods which were dye-tested for porosity . . . (x 12 magnification). The Fluoroflex-T rod (left) shows no capillary absorption of dye. It makes more stable insulation than the rod at right where porosity has enabled dye to penetrate.

Non-porous **FLUOROFLEX®-T** *rod, tube, sheet assure optimum electrical stability in parts*



At its optimum electrical values, Teflon is virtually the perfect dielectric material for UHF use. If, during extrusion or molding, however, a high degree of porosity results, dielectric strength, power factor and dielectric constant are bound to be affected. That's because *porous* insulation means *absorbent* insulators.

As the above photographs show, Fluoroflex-T is *non-porous*. This is achieved in two ways. (1) By processing on equipment especially designed to compact Teflon powder to the critical density. (2) By not bleaching out Teflon's natural spotting at the expense of optimum density.

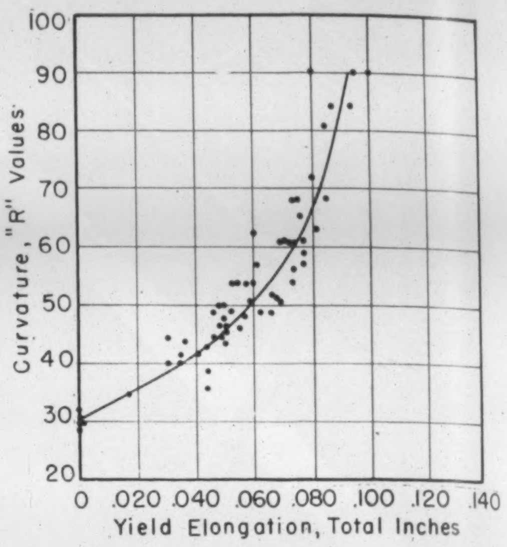
Fluoroflex-T products are also stress relieved. Result: Non-porous rods, tubes, and sheets that not only give greater electrical stability but also *dimensional* stability and fewer rejects in machining. Write for Bulletin FT-1.

**DuPont trade mark for its tetrafluoroethylene resin.*
® Resistoflex trade mark for products from fluorocarbon resins.

RESISTOFLEX
corporation
Belleville 9, N. J.

SPECIALLY ENGINEERED FLEXIBLE RESISTANT PRODUCTS FOR INDUSTRY

continued



Relationship between yield elongation and curvature expressed in "R" values.

4. Flex ("F") values will indicate the most suitable stock for a given application; this is particularly advantageous where a given stock size is used for more than one part.

5. Estimates of quality can be made at receiving time at a stamping plant. Consideration of aging changes then permits the immediate use of borderline material and storage of better material for later use.

6. Flex values can be used to show the changes in rate and degree of aging in strip steels.

7. "R" tests will show whether a cold reduced material can be directly applied to smooth surface parts or whether a roller level pass is required prior to stamping.

8. Results with deep drawn parts can be improved by using material having "F" values within a reasonably close range.

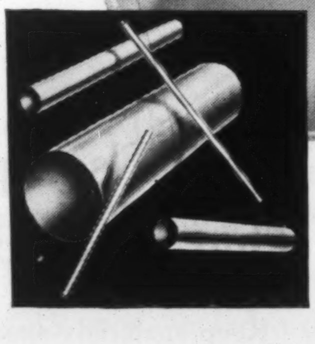
Correlations

Among the correlations discovered in the evaluation of the test were several involving the more common mechanical tests used on steel. As indicated by the accompanying graphs, a straight line relationship was found between "F" values and the yield point. A correlation also seems to exist between tensile strength and "F" values above 65. A very close correlation was obtained between "R" values and yield elongations.

No good correlation was found with results of the Olsen cup test. The authors believe the reason is that the cup test does not have any correction for material thickness.

Adapted from paper presented before SAE 1953 Annual Meeting.

TRENTWELD tubing improves durability... service life of dimpled tube heat exchangers



To provide optimum performance and durability in extreme temperature applications of their dimpled tube, aircraft heat exchangers, the AiResearch Division of the Garrett Corporation is now using TRENTWELD stainless steel tubing.

AiResearch engineers developed a technique for stepping up the cooling efficiency of their heat transfer units 26% . . . they dimple the tubes used in the construction of their heat exchangers. The dimples interrupt the smooth flow of air through the tubes and permit more rapid exchange of hot and cold molecules. But in service use these tubes are subjected to high temperatures where ordinary materials won't stand up.

That's why TRENTWELD tubing is used. For TRENTWELD is made in a tube mill by tube specialists. It is formed from accurately rolled sheet and strip and fusion welded by an exclusive process that insures complete uniformity throughout. TRENTWELD is produced in a wide range of grades, gauges and finishes and in practically any size from 1/8″ up.

Trent Tube Company engineers have successfully solved many other application problems for stainless and high alloy tubing. Their services and broad background of experience are available to help you solve yours. If you use any form of tubing, why not call in one of our representatives. And remember, *you can't buy better tubing than* TRENTWELD.

TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

"WHO CUT THIS 0.0006" UNDERSIZE?"

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DO YOU NEED A

"PUTTIN'-ON-TOOL"

for salvaging undersize parts, worn tools and gages right in your own plant?

Now, with the Chromaster industrial chrome plating unit, you can restore undersize components or worn tools to exact dimensions, easily and simply, in a matter of minutes. With Chromaster, you will be able to salvage thousands of dollars worth of material you're now throwing into the scrap bin.

Here are the facts about Chromaster:

- **SIMPLE TO OPERATE**
- **NO PREVIOUS PLATING EXPERIENCE NEEDED**
- **FAST DEPOSIT RATE. .002" per hour**
- **CHEMICALLY STABLE PLATING SOLUTION**
- **LOW PLATING COST . . . only 7 mils per sq. in. .002" thick**

Now take a look at a few of the actual savings the Chromaster has made in other plants.

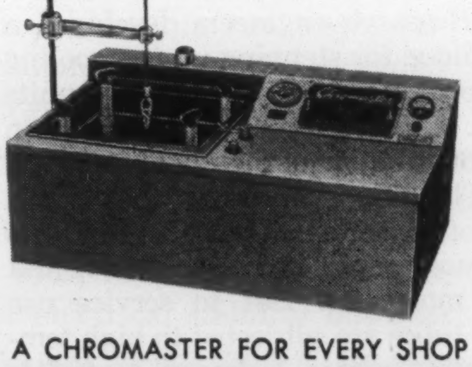
ACTUAL CHROMASTER SAVINGS

A CHICAGO TOOL COMPANY with 1500 shafts ground undersize used a Chromaster to return them to their original size with a surface finish of greater wear resistance.

A PHILADELPHIA MANUFACTURER used Chromaster to correct an oversized cylinder bore by plating to size.

A BROOKLYN FOUNDRY saved two grinding operations and almost five hours in plating time on every component with Chromaster.

A CALIFORNIA AIRCRAFT FACTORY salvaged expensive worn-down reamers with Chromaster. The new plating increased their useful life from less than a day to better than three weeks.



A CHROMASTER FOR EVERY SHOP

Model A-20 is a 20-amp, bench-mounted unit for the gage room or tool crib; plates up to 10 sq. in.

Model A-50, 50-amp, bench-mounted unit for larger shops in plating of cutting tools. Plates up to 25 sq. in.

Model A-250, 250-amp, floor-mounted unit for production plating of small parts in greater quantities or larger parts with areas up to 125 sq. in.

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A•3•3

Industrial Chrome Division
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Please send me information on industrial chrome plating with CHROMASTER.

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News Digest

Rubber . . .

continued from page 8

total needs will exceed present total capacities, natural and synthetic combined, by 25%.

Basic Disparity

He pointed out that to maintain world economy at its present levels calls for 50% more new rubber than the areas planted to rubber trees will produce in 1953; that in this country alone total consumption of new rubber this year will amount to 80% of the year's entire world crop of natural rubber.

"The difference between the total need for rubber and the available supply of natural rubber is, of course, made up by the output of the synthetic rubber industry which, save for a small fraction, is centralized in this country.

"It is quite apparent that there will be little increase in the present output of natural rubber in the foreseeable future. A seven-year span exists between planting and tapping. Meanwhile, existing plantings are depleting themselves at a rate probably higher than they are being replaced."

Don't Use Specs That Can't Be Met

Keep materials specifications realistic.

That was the warning given by J. W. Frazier, head of the materials engineering department of Hughes Aircraft Co., at the recent Basic Materials Conference in New York.

Specifications themselves can impose restrictions on availability through misuse, distorted requirements and confusion resulting from duplication," he said. "These contribute to the problem of finding specification material on the open market. The demand is greater than the supply for many items. This condition has developed with the increased application of government specifications and industry's growing appreciation of specification materials. The vendors of material are affected

PRODUCT—
Flight instrument part
MATERIAL—
Aluminum alloy
EQUIPMENT—
85 kv. x-ray machine

What's the right X-ray Film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

Soundness of this die-cast part is essential to dependable accuracy in an aircraft flight instrument. So each casting is radiographed.

For the exposures, the radiographer uses 85 kv., 35 secs., a tube distance of 30 inches, and Kodak Industrial X-ray Film, Type A—the right film for this combination of radiographic factors.

THERE'S A RIGHT FILM FOR EVERY PROBLEM

Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses and radiographic sources.

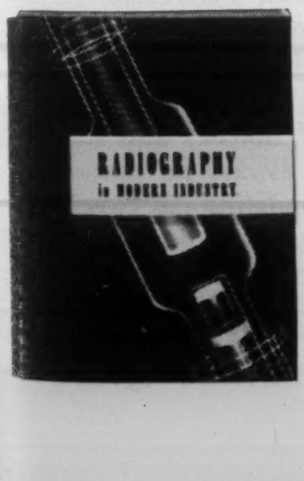
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

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by specifications and this effect is felt by the consumer. A vendor may not be able to supply specification material for any of the following reasons:

"1. Their manufacturing methods may not permit meeting all requirements.

2. Quantities involved are too small to justify the added cost and work required for certification.

3. They do not want to make materials to any specifications other than their own.

4. They feel that the customer's specifications are unreasonably strict and too demanding.

5. They just cannot keep up with the demand.

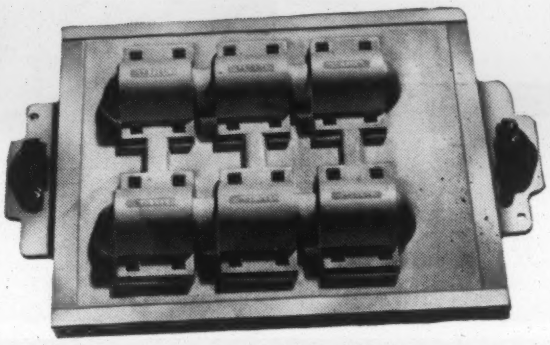
"Thus," he said, "the very instrument that provides control can complicate the selection of materials. A material specification must fulfill its obligation to product design, but it should not be such that it will unreasonably hinder or restrict procurement."

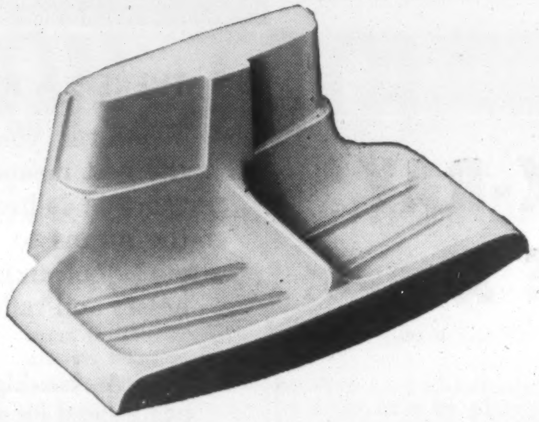
Steel for Aluminum Requires Caution

Against a background of increasing interest in high strength steels for light weight applications, such as aircraft landing gear, a note of caution has been sounded by Julius J. Harwood, assistant head of the metallurgy branch of the Office of Naval Research.

"Although aluminum alloys of much less ductility and impact resistance are presently being employed quite satisfactorily in the intended applications for these steels", he said, "comparison on the basis of ductility and impact values may be quite misleading and dangerous.

"The lower modulus of aluminum which assists in energy-absorption of shock loads and the brittle failure tendencies of steel under certain conditions must receive consideration. The possibility of rapid crack propagation and brittle failure under conditions of notches and impact loading must always be borne in mind. Tests, simulating as closely as possible service loading conditions on actual parts, should be conducted whenever the use of such high





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Parts cast by this economical method have good to excellent mechanical, electrical, and chemical properties. The resin molds readily to intricate shapes, can be machined and surface-finished easily, and can be colored before or after casting. For fast hardening with minimum shrinkage, we recommend our special accelerator.

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DUREZ 7421A CASTING RESIN

and Durez 7422 Accelerator

Address Durez Plastics & Chemicals, Inc., 1408 Walck Road, North Tonawanda, N. Y. or Rezolin Inc., 5736 West 96th St., Los Angeles 45, Calif.

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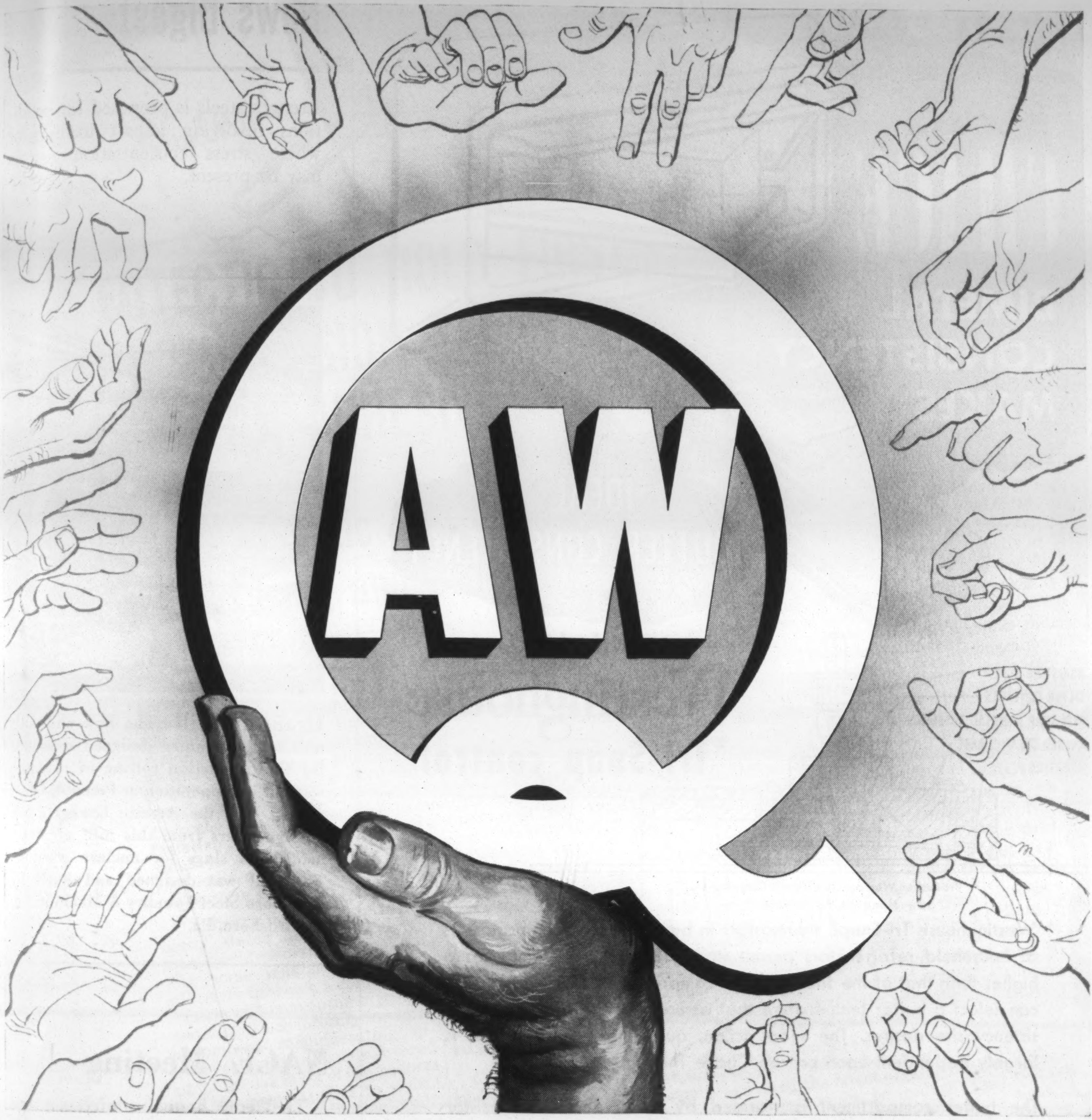
PHENOLIC RESINS THAT FIT THE JOB



Symbol of 1600 hands that know how

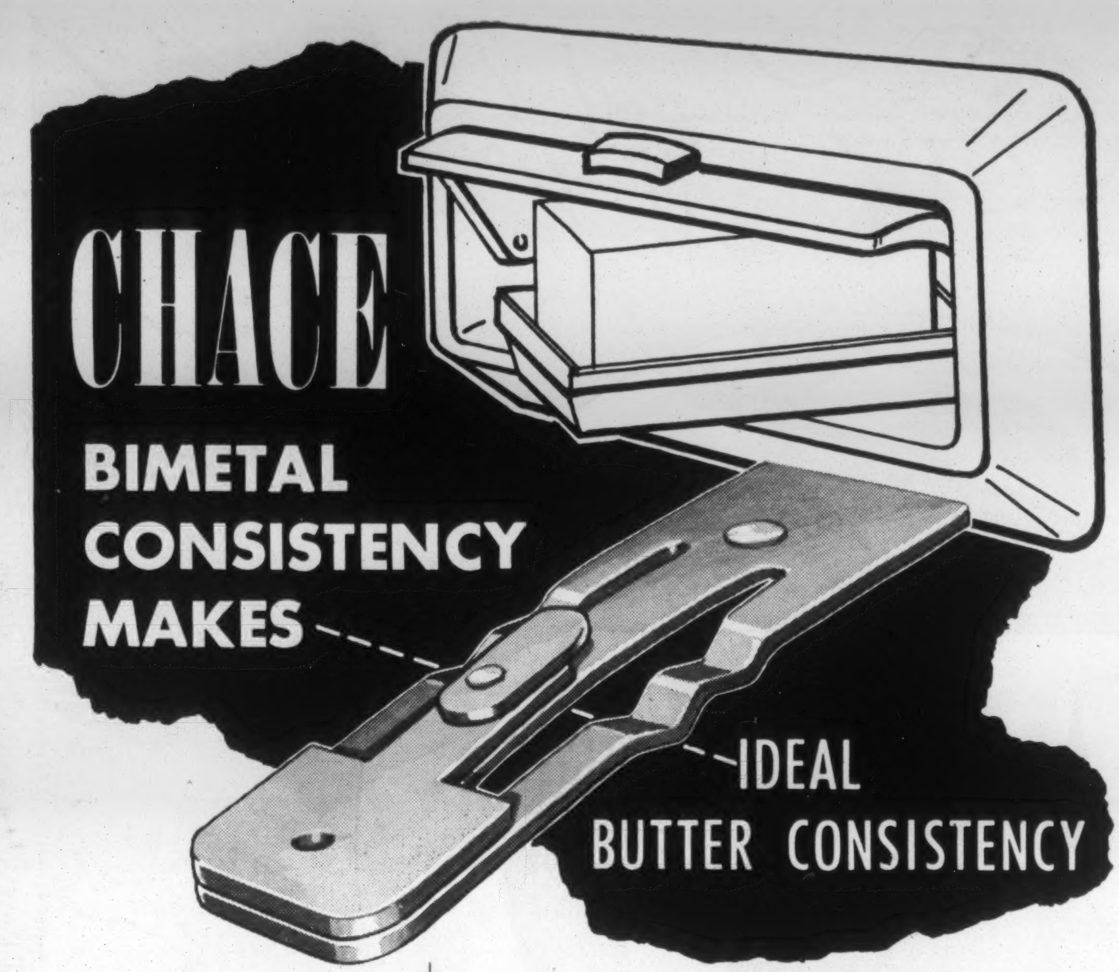
Hands pledged to a common cause — hands that are skilled at their job and devoted to building top quality into every weldment. Hands of the metallurgist, of engineers and management — most important, hands that do the welding, the shaping, the machining and the inspecting — these are the hands that spell out the meaning of AWQ — American Welding Quality.

We know of no better guarantee of quality than a skilled worker with a sincere desire to do his best. This is the know-how, the care, the quality that American Welding offers you.

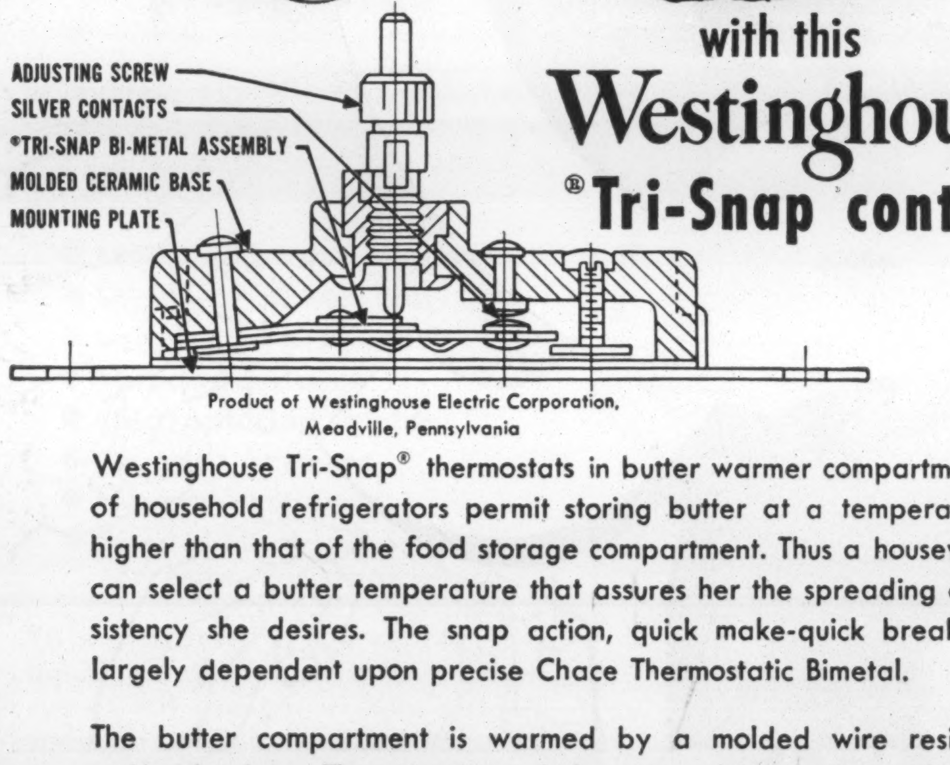
If your products involve either fusion or resistance welding of ferrous or non-ferrous metals, let us study your problem. We can apply over a third of a century's experience to your requirements — backed by 1600 hands that know how.

A company you'll like to deal with

THE AMERICAN WELDING & MANUFACTURING COMPANY • WARREN • OHIO



with this
Westinghouse
®Tri-Snap control



Product of Westinghouse Electric Corporation,
Meadville, Pennsylvania

Westinghouse Tri-Snap® thermostats in butter warmer compartments of household refrigerators permit storing butter at a temperature higher than that of the food storage compartment. Thus a housewife can select a butter temperature that assures her the spreading consistency she desires. The snap action, quick make-quick break, is largely dependent upon precise Chace Thermostatic Bimetal.

The butter compartment is warmed by a molded wire resistor under the box. The crimping of the outer edges of the slotted bimetal element shortens the over-all length, placing the center section under compression. As the bimetal deflects due to the rise and fall of ambient temperature, the "oil-can" effect of the distorted center causes a sharp make-and-break contact with the resistor. Opening the gap between contacts lengthens the "off" period, hence the spreading consistency may be controlled to the queen's taste.

Chace engineers, recognized authorities on temperature responsive devices invite you to consult with them before designing your new temperature actuated control. Our 29 types of thermostatic bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. Write for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal."

IT BENDS WITH THE HEAT
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Thermostatic Bimetal
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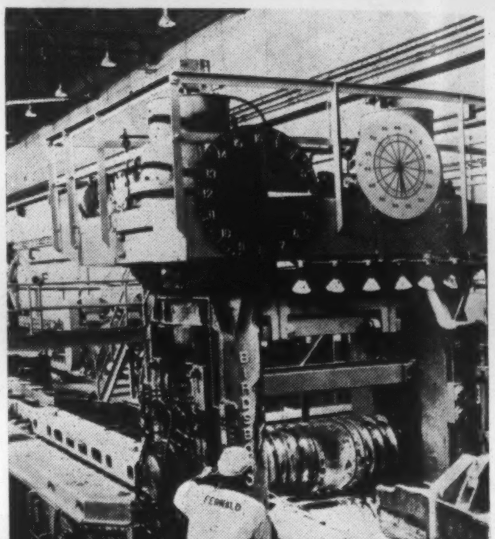
strength steels is proposed for conditions involving impact loading or where stress concentration factors may be present."



Uranium Mill The first and only mill in the country designed expressly for the production rolling of uranium was put into operation at Fernald, Ohio, recently for the Atomic Energy Commission. Bars from this mill are later made into slugs for nuclear reactors. The mill was designed and built by Birdsboro Steel Foundry & Machine Co. of Birdsboro, Pa.

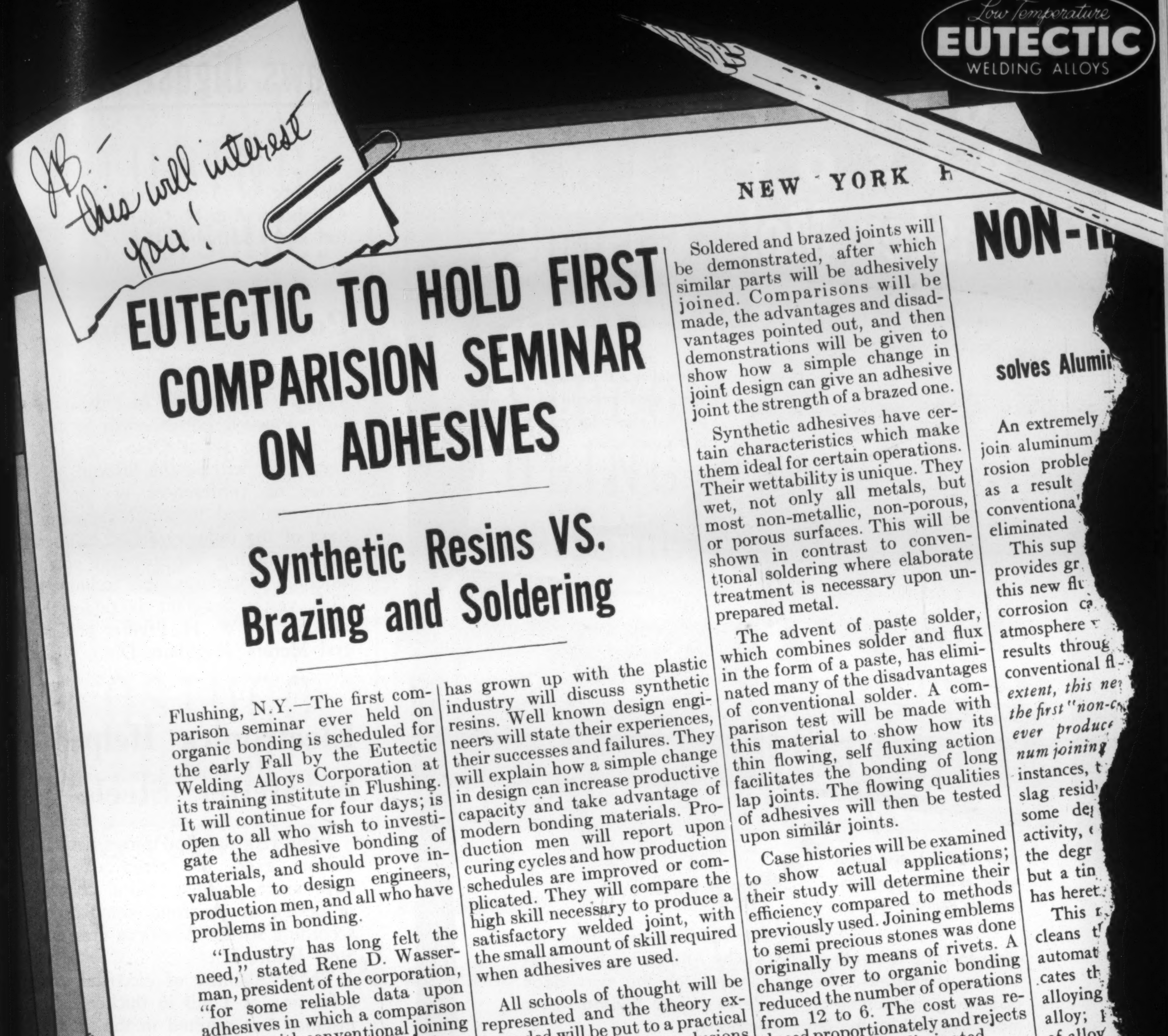
NACE Meeting

The tenth annual conference and exhibition of the National Assn. of Corrosion Engineers is scheduled for March 15 to 19, 1954, in Kansas City. F. L. Whitney, Jr., of Monsanto Chemical Co., St. Louis, is chairman of the Technical Program Committee.

Corrosion Courses

Growing interest in including corrosion courses in regular engineering curricula is reported by Dr. Norman Hackerman, University of Texas, who is chairman of the education committee of the National Assn. of Corrosion Engineers.

Schools that have started such courses or have them under consideration include: Tennessee, Stevens



Low Temperature
EUTECTIC
WELDING ALLOYS

J.B. - this will interest you!

NEW YORK

EUTECTIC TO HOLD FIRST COMPARISION SEMINAR ON ADHESIVES

Synthetic Resins VS. Brazing and Soldering

Flushing, N.Y.—The first comparison seminar ever held on organic bonding is scheduled for the early Fall by the Eutectic Welding Alloys Corporation at its training institute in Flushing. It will continue for four days; is open to all who wish to investigate the adhesive bonding of materials, and should prove invaluable to design engineers, production men, and all who have problems in bonding.

"Industry has long felt the need," stated Rene D. Wasserman, president of the corporation, "for some reliable data upon adhesives in which a comparison is made with conventional joining materials. Such information from a company manufacturing adhesives might be considered prejudiced in favor of its products and the same applies to a firm manufacturing welding materials.

"Eutectic's position as a pioneer in the research and manufacture of solders, brazing and welding alloys enables it to speak authoritatively on this subject. It can speak similarly upon adhesive bonding because of its ChemoTec Division which was organized to develop organic bonding agents. It is thus in the unique position of being able to tell the unbiased truth of the advantages and limitations of adhesives in general and the epoxy adhesives in particular."

Speakers of repute, all experts in their chosen fields, have been approached. All welcomed the idea as one which will do much to clarify a very obscure situation. A metallurgical engineer will explain what can be done with metals and, within the limits of present day knowledge, what cannot be done. A man who has grown up with the plastic industry will discuss synthetic resins. Well known design engineers will state their experiences, their successes and failures. They will explain how a simple change in design can increase productive capacity and take advantage of modern bonding materials. Production men will report upon curing cycles and how production schedules are improved or complicated. They will compare the high skill necessary to produce a satisfactory welded joint, with the small amount of skill required when adhesives are used.

All schools of thought will be represented and the theory expounded will be put to a practical test so that definite conclusions may be drawn.

Certain factors must be explained in detail and in relation to the metallurgical or organic nature of the bonding agent. The tensile strength of a specially formulated epoxy resin base adhesive, may be more than adequate for the joint involved. The peel strength, however, may be negligible. This weakness, common to many adhesives, can be counteracted by a change in design. This feature, the importance of design, will be stressed throughout the seminar. Butt joints are practical only if the filler has good adhesion and strength. A solder conceivably could have an adhesive strength at the interfaces of 50,000 psi. through alloying with the parent metal, but the strength of the joint would be that of the solder. Thus if the solder had a tensile strength of 6,000 psi. this would be the breaking point of the joint despite the high strength at the interfaces.

Soldered and brazed joints will be demonstrated, after which similar parts will be adhesively joined. Comparisons will be made, the advantages and disadvantages pointed out, and then demonstrations will be given to show how a simple change in joint design can give an adhesive joint the strength of a brazed one.

Synthetic adhesives have certain characteristics which make them ideal for certain operations. Their wettability is unique. They wet, not only all metals, but most non-metallic, non-porous, or porous surfaces. This will be shown in contrast to conventional soldering where elaborate treatment is necessary upon unprepared metal.

The advent of paste solder, which combines solder and flux in the form of a paste, has eliminated many of the disadvantages of conventional solder. A comparison test will be made with this material to show how its thin flowing, self fluxing action facilitates the bonding of long lap joints. The flowing qualities of adhesives will then be tested upon similar joints.

Case histories will be examined to show actual applications; their study will determine their efficiency compared to methods previously used. Joining emblems to semi precious stones was done originally by means of rivets. A change over to organic bonding reduced the number of operations from 12 to 6. The cost was reduced proportionately and rejects were practically eliminated.

Case histories such as this will be used to show how others have adapted the latest organic bonding techniques to reduce the number of operations and produce a more satisfactory product.

It is hoped this seminar will be a real contribution to industry and will make known the conditions under which an adhesive bond will be satisfactory—and when it will be unsatisfactory. The corporation feels it is in a unique position to demonstrate both bonding methods and to leave industry to select that most suitable for its requirements.

The seminar will be presented as a service to industry. There will be no charge, but those attending will be expected to pay their own transportation and accommodation charges. Requests for further information should be made to Eutectic Welding Alloy Corporation, 40-40 172nd Street, Flushing, New York.

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Plaster Mold Castings

Atlantalloy #31 meets every specification to perform satisfactorily in this application.

Skirt door operating mechanism as installed on Pennsylvania Railroad cars.

Parts for railroad cars must be able to take a beating. That's why Atlantalloy #31 High Tensile Manganese Bronze is used for the skirt door operating mechanism on the Pennsylvania Railroad cars manufactured by the Budd Company.

Atlantalloy #31 is characterized by its punishment-absorbing ability. It requires no heat treatment to attain its high physical properties, having ultimate tensile of 100,000, yield point of 60,000, and Brinell hardness of 190. It has a minimum elongation of 7% in 2 inches. These properties are inherent in the as-cast condition.

The Atlantalloy plaster mold casting process turned out a rugged operating mechanism which required no machining and which could be installed simply by drilling two holes.

Atlantic's engineers will be happy to show you how Atlantalloy plaster mold casting can help solve some of your own problems. Write for a free copy of High Quality Precision Castings for Industry today!

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Institute of Technology, Missouri, Oklahoma A & M, California, Houston and Oklahoma.

Porcelain Forum

The porcelain enamel industry's annual interchange of ideas—the Shop Practice Forum—will be held Sept. 16 to 18 at Ohio State University. It will be the fifteenth in a series of conferences of practical shop men and technical representatives of the industry aimed at insuring continuing improvement of enameling procedures and techniques. This year's program is under the direction of W. H. Pfeiffer of General Motors' Frigidaire Div.

Electronics Helped by Better Steels

Improved electrical properties and thinner gages of "electrical" steel have made possible radical changes in design of electronic components, according to the American Iron and Steel Institute.

The availability of electrical strip a fraction of a mil in thickness, for instance, has resulted in the production of extremely thin magnetic cores for high frequency magnetic amplifiers and "flip flop" magnetic components in computer devices.

Improved crystal structure has made possible a weight saving of about 20% in a giant utility power transformer weighing 500,000 lb, the AISI says.

Look for Ideas in AEC Materials

New materials developed for atomic energy uses will be found valuable by those in industry who are constantly on the alert for the application of new materials and new ideas, according to J. C. Robinson of the Atomic Energy Commission.

The assistant director of AEC's Division of Engineering outlined his views on "Materials and the Atomic

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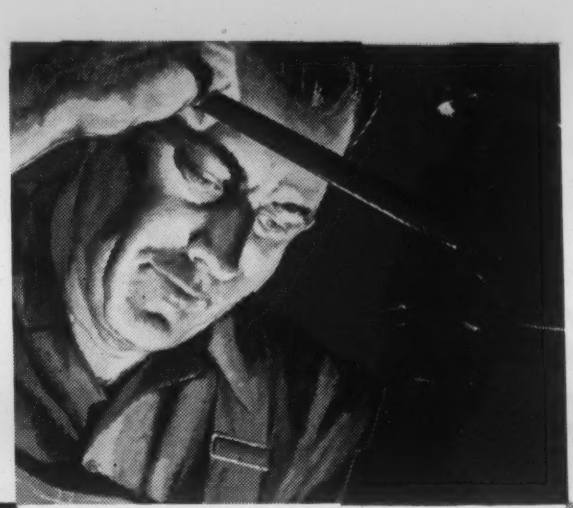
is versatile!



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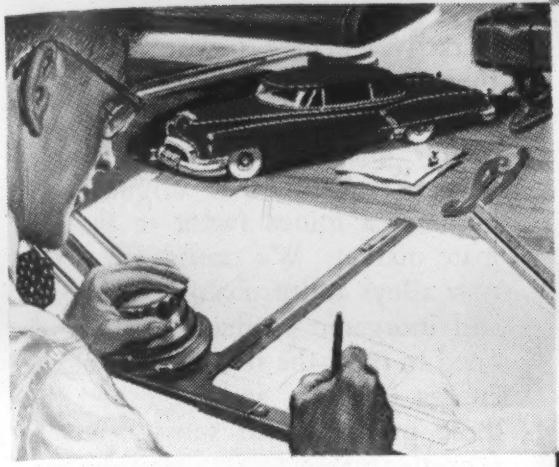

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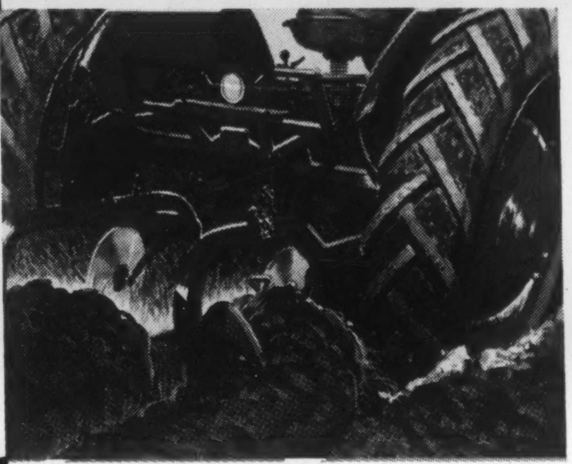
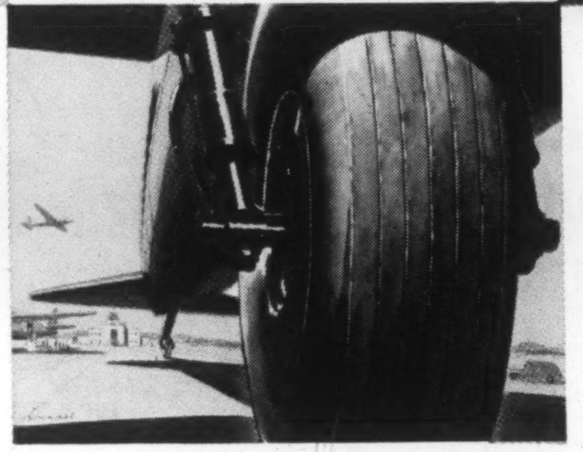


OSTUCO
TUBING
is versatile!



OSTUCO
TUBING
is versatile!

a basic material in better design

From industry's drawing boards come more and more plans for products using OSTUCO Steel Tubing. Strong, light weight, easy to form, OSTUCO Tubing is found in everything from shock-absorbers to sewing machines and tricycles to table lamps. Biggest users of OSTUCO Tubing are industries famed for their standards of high quality—manufacturers of aircraft, automobiles, appliances, electric products, tools, and machinery.

Having our own steel source as a member of the Copperweld family and with facilities modernized and greatly expanded, The Ohio Seamless Tube Company is now, more than ever, *your best single source* . . . a tubing specialist that manufacturers, forges and fabricates all at one plant. Consult our experienced engineers about OSTUCO Tubing for your current requirement or for redesigning your products. Write for new informative catalog, "Ostuco Tubing."

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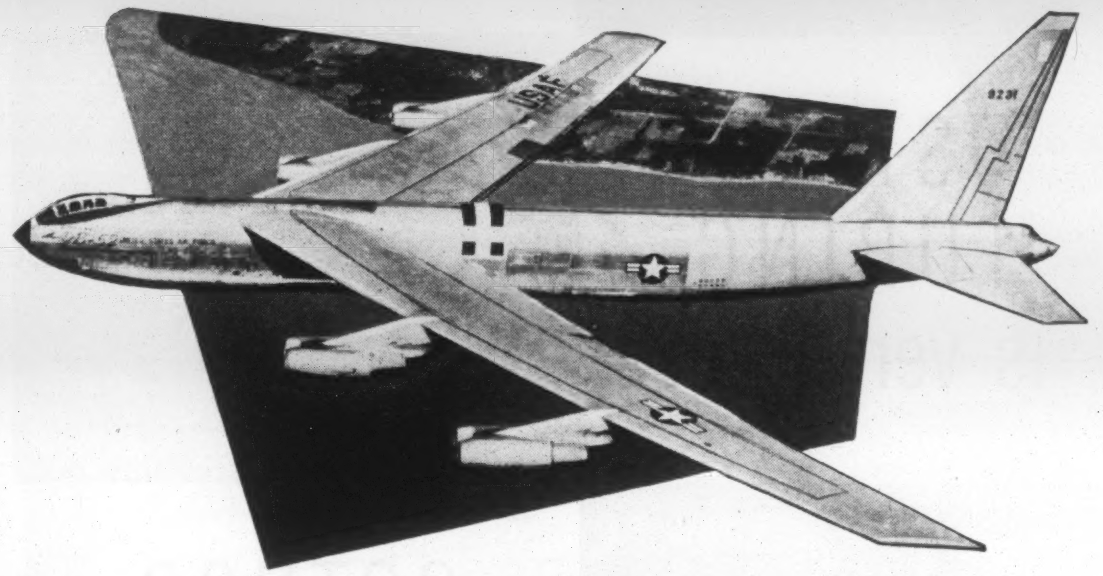

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Powerful PRATT & WHITNEY AIRCRAFT J-57
Engines employ INVESTMENT CASTINGS by

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PRODUCERS OF AIRCRAFT AND INDUSTRIAL INVESTMENT CASTINGS

Today, when aircraft and aircraft engine builders alike demand the utmost in dependable precision castings, they look to Misco for accuracy, large volume, and substantial production savings.

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The Misco Precision Casting Process, with rigid dimensional and metallurgical control, X-Ray and Zyglo inspection, affords every assurance that customer requirements are met.

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News Digest

Age" at the Basic Materials Conference held recently in New York.

New Materials

"It is a matter of history" he said, "that new alloys and other materials are gradually developed to fill a specific need after the need becomes large enough to make it economically attractive. These new materials are then found to have properties which make them desirable for other completely unrelated processes or products. Frequently the original need becomes a minor factor in the ultimate market. We confidently expect new alloys and probably new organic and inorganic products to be developed to meet the needs of the atomic energy industry, and we expect that these products will subsequently be found valuable to you who are constantly on the alert for the application of new materials and new ideas."

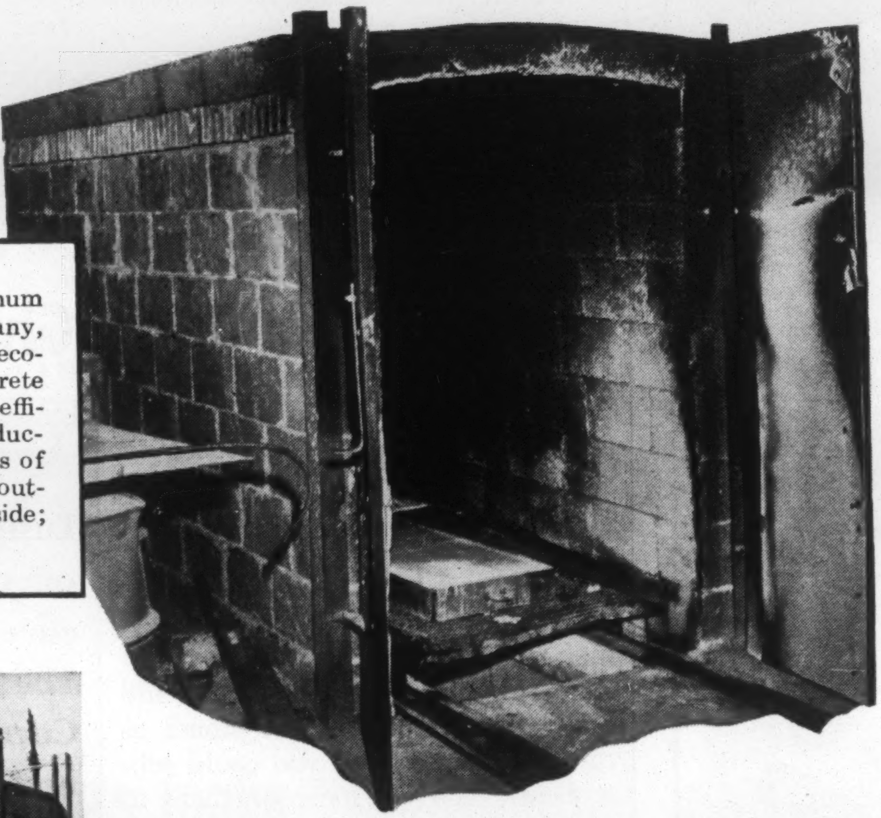
Better reactor materials would be desirable, he said, but "there is even greater likelihood that new materials will be developed for power reactors than for production reactors . . . Production reactors generally operate at fairly low temperatures, with the result that requirements for corrosion-resisting and mechanical properties of the materials of construction are not too hard to satisfy with presently available products. But industrial power reactors, which are most certainly going to be built, will operate at higher temperatures. Water, liquid metals, or liquid salts might be the coolants. New, better materials will be a 'must' if they are to remain operative for reasonable periods of time. Military power reactors may be practical in some cases if their life is measured in months. But industrial power reactors, to be competitive as a source of heat, must be amortized over an extended term of years."

About zirconium he said: "We have brought the cost of pure zirconium down from $350 per pound to between $10 and $15 per pound, and this is on a production rate of only 75 tons per year. Zirconium is one of the most abundant elements in the earth's crust, so there is no concern as to continuity of supply. The only factor which holds zirconium back is that it is still too expensive for most uses. And it will remain expensive until a large use is developed. The typical vicious circle exists. Theoretically zirconium should

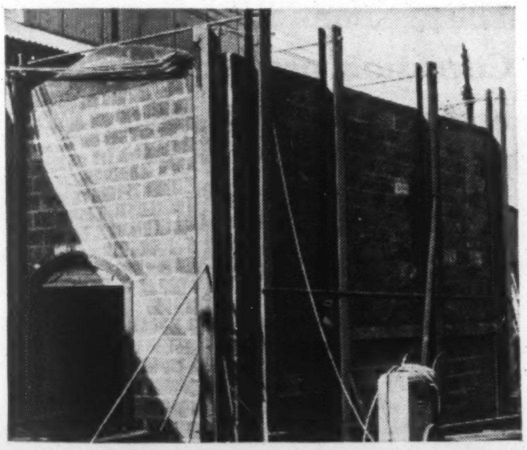
What's NEW in Refractories?

REFRACTORY CONCRETE BLOCKS

Speed Construction...Cut Costs



PRE-HEATING FURNACE for aluminum scrap at General Smelting Company, Philadelphia, Pa., was quickly and economically built with refractory concrete block. It was designed for peak efficiency at an estimated 30% cost reduction over conventional methods of construction. Furnace is 16′ long outside, 3′9″ wide and 5′9″ high inside; generates temperatures to 1500°F.



UNDER CONSTRUCTION—General Smelting Company was so pleased with the performance of the pre-heating furnace they specified refractory concrete blocks again for this new calcining kiln settling chamber. Roofs of both installations are monolithic sections of refractory concrete.

Here's a new idea in refractories that promises new economies in many industrial plants. Concrete block made with *refractory* concrete chalked up a big 30% saving in construction costs on a pre-heating kiln at General Smelting Company, Philadelphia, Pa.

The large blocks were quickly placed by plant labor. No form work was needed. And they furnish both heat resistance and structural strength.

Whether in block form, or placed on the job, *refractory concrete* assures long-service life. With Lumnite* calcium-aluminate cement and suitable aggregates, it can be made to take high temperatures—often up to 2600°F. Low volume change makes it highly resistant to thermal shock, and it also resists corrosion.

FOR CONVENIENCE, you may prefer to place refractory concrete made with prepared castables (packaged mixes of Lumnite Cement and aggregates selected for specific temperatures and insulation service—add only water). They are made by refractory manufacturers and sold through their dealers. For more information, write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

MM-L-82

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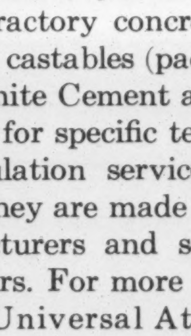

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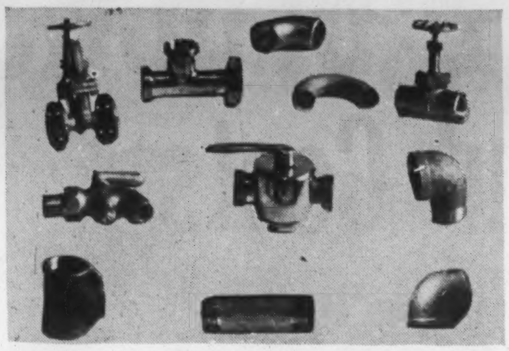
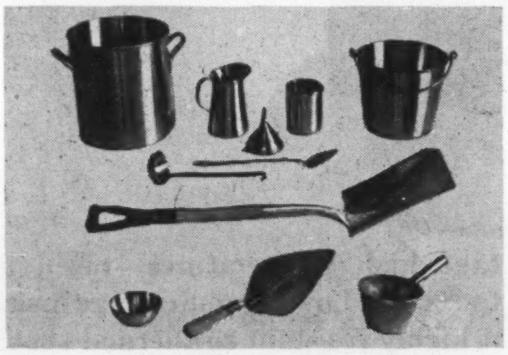
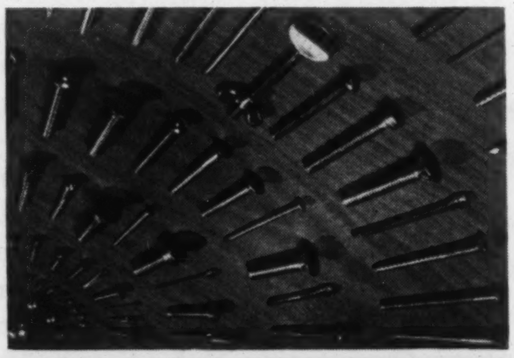


FITTINGS: Standard, extra heavy, screwed, welding, sanitary, flanged.
VALVES: Cast, forged, needle, relief; stop cocks, pet cocks, faucets. Pumps.

WELDED PIPE: Schedules 5, 10, and 40.
SEAMLESS PIPE: Schedules 40 and 80.
WELDED TUBING, to 48" O.D.
SANITARY TUBING, ORNAMENTAL TUBING, FLEXIBLE HOSE.



Beakers, bowls, buckets, dippers, drums, funnels, ladles, measures, pails, pitchers, scoops, shovels, sinks, sponges, spoons, stock pots, trays, trowels.



FASTENINGS: bolts, nails, nuts, pins, rivets, screws, washers.
HARDWARE: balls, chain, float balls, handles, hinges, brushes, wire cloth, turnbuckles, wire.

Types 302—303—304—316—347
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News Digest

cost half as much per pound as titanium when produced from the same size plant."

Hafnium

About hafnium he said: we can't supply you now but "we think that someone should be considering hafnium as a metal for jewelry. It is heavy, probably as tarnish resisting as gold, and can be formed and polished beautifully."

Another idea for jewelry based on a phenomenon which is now merely a nuisance was suggested. "Transparent materials such as glass and various crystals including precious and semi-precious stones have what are called 'color' centers, which account for the material having a certain color. These are affected by various kinds of irradiation, so that the color can be changed. We call it radiation damage, because it limits the length of time that we can use ordinary glass in the presence of various kinds of radiation. You might find that it is a useful means of creating or changing color of transparent materials. For instance, if you are in the business of making 'diamonds' or other jewels for ten cent store rings, might it be cheaper and easier to make all of the stones as colorless diamonds if you could subsequently convert some of them to rubies, emeralds, etc?"

Navy Tries Plastics for Water Tanks

Reinforced plastic tanks for fresh water and oil will be experimentally installed in five Navy minesweepers, according to Rear Admiral Homer N. Wallin, Chief of the Bureau of Ships.

The tanks ranging in size from 100 to almost 1700 gal, will be 30 to 40% lighter than comparable metal tanks usually made of Monel or aluminum bronze. They will undergo service evaluation to determine their suitability for large scale production and installation. It is believed they would be competitive in price to metal tanks, should they be made in sufficient quantity.

In addition to light weight, the

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Treats More Square Feet Per Gallon

Luster-on Khaki or Olive Drab offers up to 3500 square feet per gallon of treated work. Why settle for less?

Luster-on®

Gives More Hours of Resistance

Luster-on and baked lacquer offer up to 1000 hours resistance on your bright finishes to 100% humidity at 120°F. Corrosion protection is phenomenal. Why settle for less?

You don't have to settle for less if you always specify Luster-on — the original passivating cold bright dip for zinc; also available for Khaki or Olive Drab protective finish. Gives uniform paint bond for die castings.

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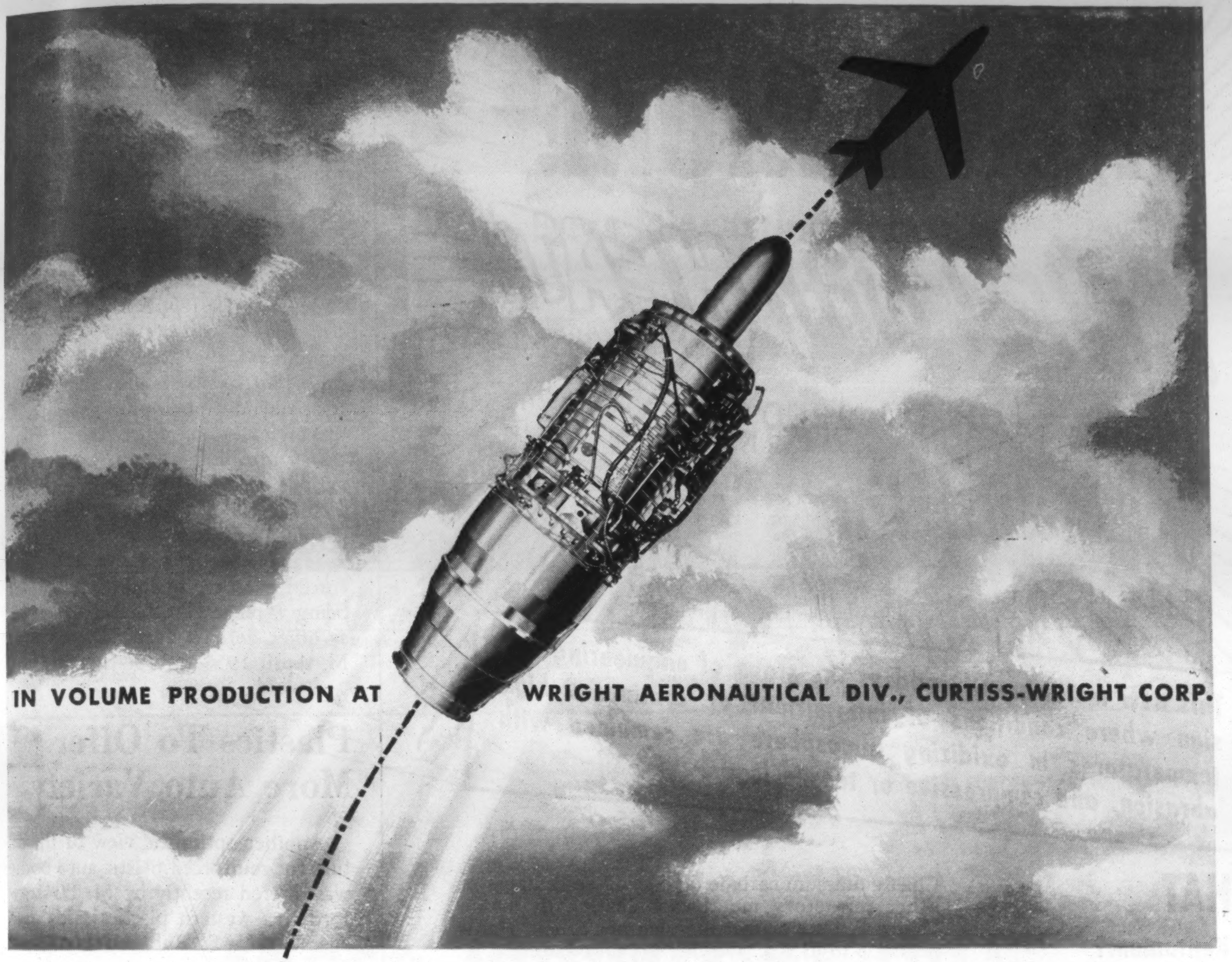
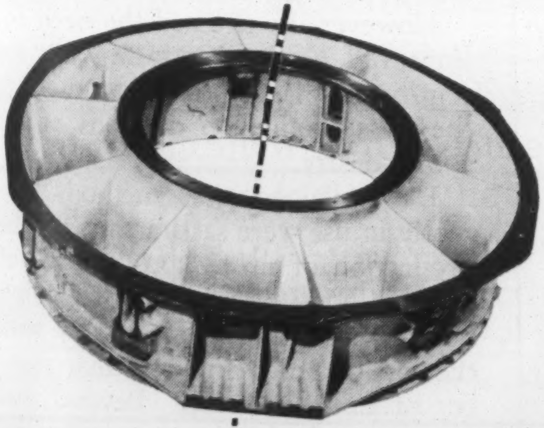

IN VOLUME PRODUCTION AT
WRIGHT AERONAUTICAL DIV., CURTISS-WRIGHT CORP.

Ductalloy® castings make "impossible" parts producible



Wright J-65 jet engine main bearing support . . . impractical to machine from one piece. Readily produced as a weldment of two Ductalloy precision castings.

This highly stressed part secures the 7,200-lb. thrust Wright J-65 jet engine in the aircraft, carries major structural members ahead of and behind it, and mounts a main shaft bearing in its center. Air roars between the carefully contoured inner and outer rings.

As originally hogged out from an aluminum forging on an experimental basis, this part required some 1200 hours of machining—impractical for volume production. Redesigned by Curtiss-Wright Corporation's Wright Aeronautical Division as a weldment of two Ductalloy precision castings, it requires only simple turning and facing plus 25 ft. of welding to assemble the ten interconnecting stainless steel struts. An "impossible" part for volume manufacture in other metals which would meet specifications, it is rendered readily producible in Ductalloy—Brake Shoe's ductile cast iron that combines high strength with the casting and machining qualities of gray iron.

YOUR PROBLEM—Ductalloy may solve your problem if it involves economical production of complex metal shapes that are difficult to cast in steel, expensive to forge, or lacking strength in gray iron. Brake Shoe's experience, research laboratory and experimental foundry are available to help you best utilize its unusual combination of characteristics. Write for your copy of this new technical bulletin today.

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ductile
cast
irons

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KENTANIUM

LIVES with HEAT...

(UP TO 2200° F)

and likes it!

This new metal greatly widens the scope of engineering design where conditions of intermittent or continuous high temperatures in oxidizing atmosphere are combined with abrasion, and compressive or tensile loads.

WHAT is Kentanium?	Chiefly titanium carbide (and small percentages of other refractory metal carbides), with nickel "binder". Uses neither tungsten nor cobalt. Hardness: Up to 93 RA. Weight: ⅔ that of steel.
WHAT can it do?	Resist thermal shock, withstand oxidation and abrasion, retain great strength at high temperatures (1800°F and above).
WHERE is it in use?	Successful applications include: Valves, valve seats, reduction crucibles, anvils for spot welding, hot extrusion die inserts, bushings, thermocouple protection tubes, flame tubes, furnace tong tips, balls for hot hardness testing, nozzle vanes and blades for jet engines, and many others.
WHAT forms are made?	Tubes, rods, bars, flats by extrusion process. More complex parts by machining from pressed slugs before sintering; extremely accurate parts by grinding to required tolerance after furnace sintering.
HOW can you use it?	This remarkable new metal, available in many "grades" to meet specific combinations of imposed conditions, can best be adapted to your high temperature problem by cooperative effort. Our engineers will be glad to discuss how you can get best results from Kentanium.

An Exclusive Development of KENNAMETAL® Inc., Latrobe, Pa.

KENTANIUM

HEAT-RESISTANT, HIGH-STRENGTH, LIGHTWEIGHT CEMENTED TITANIUM CARBIDE

Navy is interested in the glass fiber-polyester material because it is nonmagnetic and uncorrodable. Flammability may limit its application, however.

Since oil storage tanks on minesweepers are irregular in shape, with flat sides conforming closely to the contour of the ship, special design problems have been encountered. The relatively low modulus of the material makes deflection, rather than strength, the controlling design factor, and various internal stiffening or tension members are needed to brace unsupported areas.

Many other applications for reinforced plastics, including boats, are being explored by the Navy, as well as other defense agencies (see M & M, April 1953, p. 186).

* * *

Plastics To Offer More Auto Variety

Another optimistic view of the future for reinforced plastic auto bodies was offered recently by M. B. Crawford, Jr., western plastics sales manager for U. S. Rubber's Naugatuck Chemical Div.

He predicted that in the "not-too-distant future" the freedom of design inherent in reinforced plastics would make it possible to offer the American public "hundreds and hundreds of body styles instead of a dozen or two" for cars being produced by the country's major manufacturers.

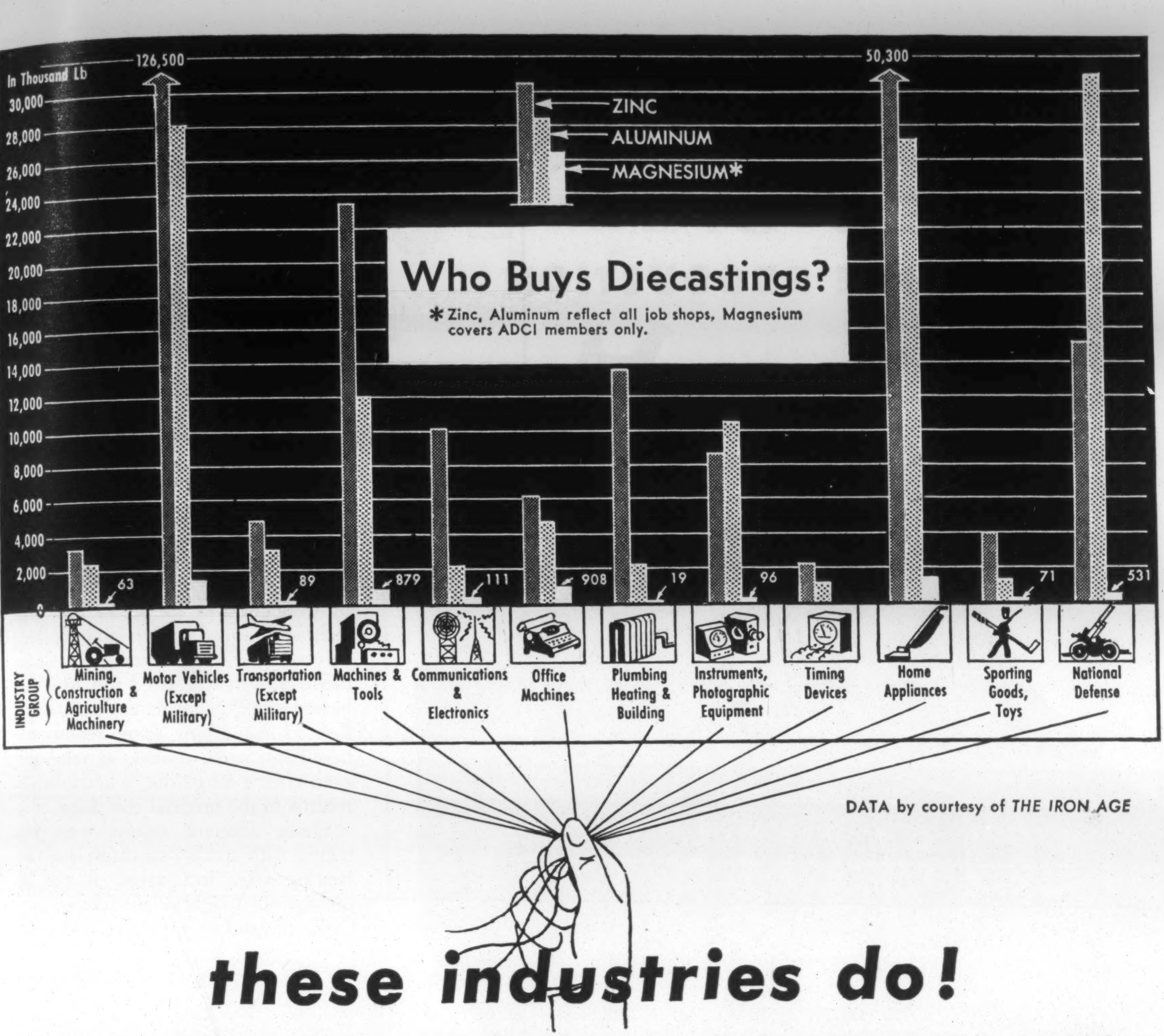
However, he stressed the need for improved production techniques for reinforced plastics to adapt them to the mass production methods of the auto industry.

He explained that methods currently in use were satisfactory for the production of up to 15,000 units of a single body design. At that point, he said, costs compare favorably with the cost of producing a similar number of units in metal. Beyond that figure metal construction costs decline, he added, while plastics production costs remain at about the same level.

* * *

British Exhibit Plastics Advances

New products and new fabrication techniques were on view at Britain's



DATA by courtesy of *THE IRON AGE*

these industries do!

Applications of zinc base die castings are so varied and widespread, it would be almost impossible for anyone to go through an ordinary day's routine of living without using—directly or indirectly—a large number of devices, appliances and services in which zinc alloy die castings form essential parts. The chart above, which shows sales by job shop die casters in 1952, tells its own story. More significant, perhaps, is that these sales were nearly six times the value of sales in 1936. Even considering rising costs and prices during the 16-year period, this is a remarkable record, and is representative of the entire die casting industry.

A prime factor in the steadily growing use of die castings has been the recognition of the die casting process for what it has proved itself to be: One of the fastest and most economical production techniques at the command of the metal-working industry today!

DIE CASTING is the Process

ZINC, the Metal

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MICROCAST PRECISION CASTINGS PROCESS

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JET ENGINE PRODUCTION

USAF
microcast®
MICROCAST parts are structurally sound, dimensionally uniform and smooth of surface.

Complicated power blades and buckets for jet engines require the use of high-melting-point alloys that are slow and costly to produce by ordinary methods of manufacturing. The Microcast Process of investment casting produces these parts for use as cast, reducing machining and grinding operations to an absolute minimum. This process is particularly well suited to similar applications requiring the use of high-temperature alloys. Let us show you how MICROCAST parts can fit into your product's design.

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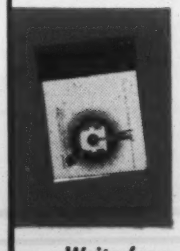


Write for booklet and information on new color movie.

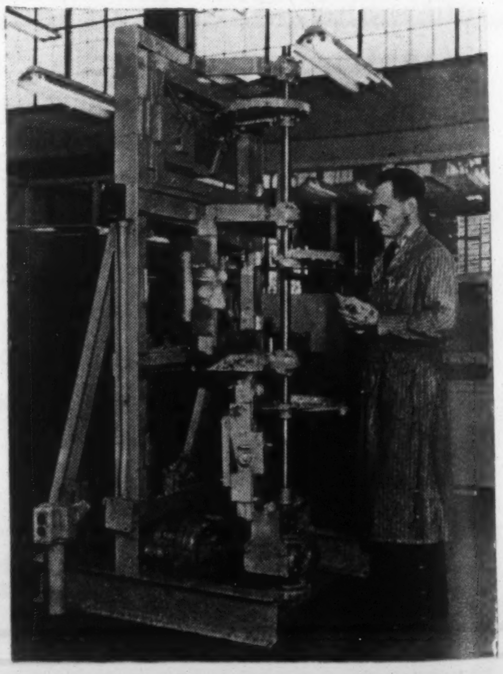
second Plastics Exposition held recently in London.

Among the most spectacular exhibits were various shapes made of reinforced plastics. These included a 150-lb auto body and 3600-gal water tank of glass-polyester material, and a 30-ft glider wing and 14-ft radar reflector made of resin-impregnated asbestos.

Another radar reflector, in the form of a parabola 18 ft long and 3½ ft high, had a core of honeycomb paper with outer skins of phenolic-impregnated asbestos cold-glued to it.

The effects of exposing plastics to atomic radiation were also demonstrated. Polyethylene is strengthened by irradiation in the atomic pile and resists prolonged immersion in boiling solvents. It also develops a shape memory. An irradiated rod which is heated until malleable and twisted or pressed into a new shape retains the new form when cooled. If reheated, even after a long time, it immediately returns to the original rod shape.

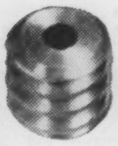
Quite different results were obtained with methyl methacrylate. By heating after irradiation, it can be turned into a lightweight foamed material encased in a tough outer skin.



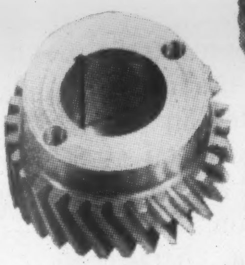
Lock Slammer Chrysler's Structures Lab uses this untempermental machine to make sure its car locks can be slammed at least 50,000 times. Three simulated car doors successively swing open and slam shut 740 times an hour.

☐ High Strength

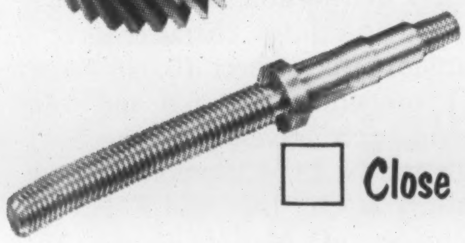
☐ Fine Surface



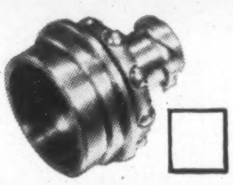
☐ Toughness



☐ Hardenability



☐ Close Tolerance



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High-speed automatics take full advantage of the cost-cutting qualities of Republic Bars. Designers can make full use of the high strength and uniform structure of these cold drawn bars. Production men can get the ideal combination of wearability and strength out of the uniform hardenability and toughness of the alloy steel.

And . . . Republic 3-Dimension Metallurgical Service focuses the experience of our Field, Mill, and Laboratory metallurgists on your production problems for the best answer with Republic Cold Drawn Alloy Steel Bars.

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ALLOY STEEL BARS

The PROTECTION of ALUMINUM

Drawing courtesy of Piasecki Helicopter Corporation, Morton, Pennsylvania

THE H-21 Piasecki Tandem Helicopter—the "Work Horse" —is ideally suited for rescue work in areas inaccessible by other means, and in all kinds of rough weather.

For durable paint adhesion and high corrosion-resistance aluminum parts of the "Work Horse" are Alodized. The "Alodine" protective coating chemical bonds paint, extends paint life, and protects unpainted aluminum.

Because of its economy, effectiveness, and ease of application, the Alodizing process is finding wide-spread use in the aircraft field and in other industries fabricating products of aluminum.

Alodized aluminum meets the requirements of Military Specification MIL-C-5541. Write or call for coating and process data on "Alodine".

"Alodine" Trade Mark Reg. U. S. Pat. Off.

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News Digest

Joining Titanium— AWS Hears Latest

Recent developments in welding and brazing of titanium and its alloys were revealed in a special session on the new metal at the June meeting of the American Welding Society in Houston, Texas.

Spot welding characteristics of titanium-carbon sheet (0.040—0.047 in.) containing 0.1, 0.4 and 0.6% carbon were investigated by E. F. Holt and N. L. McClymonds of P. R. Mallory & Co., Inc., and F. H. Vandenburgh of Mallory-Sharon Titanium Corp. For a basis of comparison they used Type 302 stainless steel.

They found material in the "as received" condition (hot rolled, annealed and pickled) had a "reasonably low and uniform" contact resistance unaffected by carbon content, and welds made on the material were of acceptable strength and consistency. Bright finished stainless seemed to have somewhat higher contact resistance with greater variations.

Shear Strength

Weld shear strength, they found, was relatively unaffected by carbon content, although ductility (ratio of tension-shear strengths) was lowered substantially with increasing carbon content. The ratios ranged from 0.5 on the 0.1% carbon to 0.2 on the 0.6% carbon alloy. Shear strength in the stainless was slightly higher, a difference they attribute to the higher properties of the cold-rolled sheet, and the stainless ratio was about 0.75.

The authors said they got welds of good strength, quality and consistency over a wide range of conditions. Direction of rolling and weld force apparently did not affect weld strength, and weld ductility was not affected by either weld time or weld current. Weld "splash," they said, was much less pronounced in the titanium than in the stainless.

For optimum welding conditions, they suggested 11,000 amp. current, 1350 lb force and 18 cycles time.

Brazing Methods

Methods for brazing commercially pure titanium with an oxyacetylene torch, by electric resistance heating and in a furnace using an inert gas atmosphere of commercial purity

"today's "wonder drug" for industry

NOW . . . when it's needed most . . . the greatest cost-aving, labor-saving finishing development in a decade!

ou manufacture metal parts of any kind — this great new ic approach to finishing will give you ALMOST UNBE-VEABLE COST REDUCTIONS.

ersheen Speed Finishing eliminates to a great extent previ- time-consuming operations like filing, grinding, polishing, ting, buffing. It does away with costly hand deburring, other hand operations requiring the use of large quantities expensive materials and extremely costly skilled labor.

rly all types of metal parts — stampings, castings, forgings, chined parts — FERROUS OR NON-FERROUS can be ultaneously finished by the SUPERSHEEN process to absolute micro-exactness. Parts now being successfully SUPERSHEENED range in size from very small to large parts, such as jet engine blades and large gears.

Typical savings range from 48% on a threaded cast iron pipe "T" — to a 95% savings on a steel trigger with intricate configurations.

SUPERSHEEN SPEED FINISHING is used by hundreds of corporations, from the very small to the world's largest. Among them — GENERAL MOTORS CORPORATION, TIMKEN ROLLER BEARING CORPORATION, EASTMAN KODAK CO. — Mail the coupon below for complete information.

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The world's most complete and largest selling line of Finishing Barrels, Fixture and Dual Action Machines and Handling Equipment. Whatever your problem — from microfinishing small precision parts to cutting down large castings — Supersheen has the necessary equipment.

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Almco SUPERSHEEN has a great selection of different compounds — each for a specific type of barrel finishing process. This wide selection of scientifically combined compounds makes it possible to choose one which can give optimum results for a given job.

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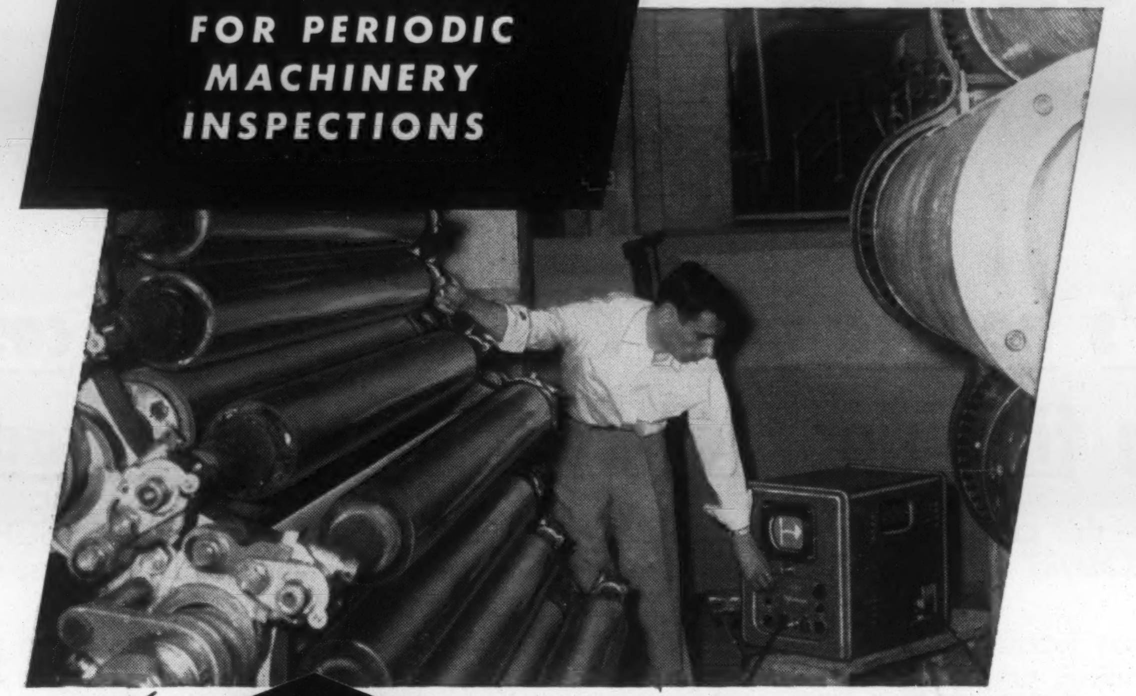
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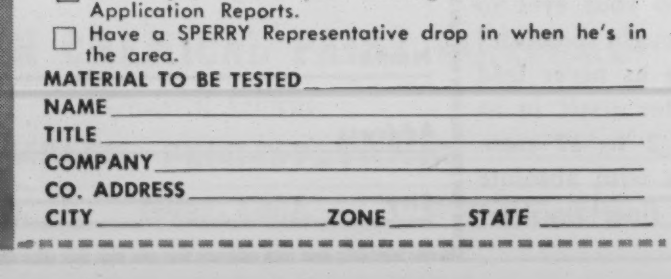
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were reported by J. M. Parks and N. A. DeCecco of Armour Research Foundation.

They made torch heated single lap joints which had high shear strength, and resistance heated lap joints strong enough so that tension specimens broke outside the weld. Joints brazed with fine silver broke with a ductile shear fracture whereas joints made with other braze metals broke with a brittle shear fracture.

Experimental joining of commercially pure titanium and a 7% manganese-titanium alloy by recrystallization welding produced joints with shear strengths equal to the shear strength of the annealed titanium alloy.

News of Engineers

Burns George, vice president in charge of sales, Vanadium-Alloys Steel Co., has been named recipient of the 1953 McFarland Award for Achievement in Metallurgy by the Penn State chapter, American Society for Metals.

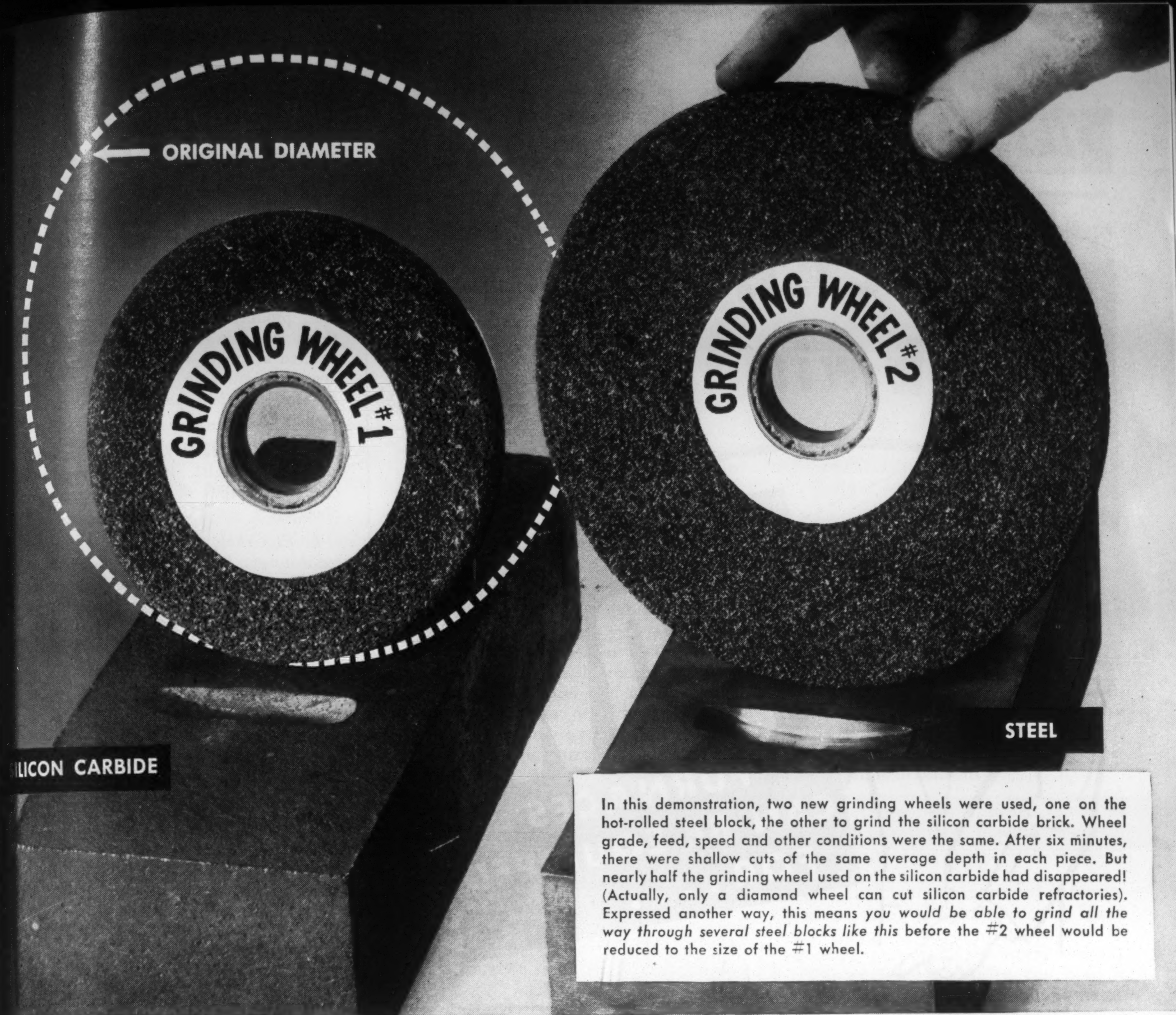
Recent changes in personnel at *Enthone, Inc.*, include the appointment of *Hubert M. Goldman* to the newly created post of assistant sales manager and technical engineer; *Francis A. Schneiders* to the position of technical service manager; and the addition of *Lawrence J. Durney, Jr.* and *Edward F. Foley* as research chemists.

In a move made necessary by a recent expansion program, Udylite Corp. announced that *L. K. Lindahl* is relinquishing his duties as president to devote full time to his position as chairman of the board and that *Clyde H. Reeme* will assume the presidency. In other company shifts, *Lawrence V. Nagle* has been named executive vice president and *Arthur L. Barak*, treasurer.

Appointment of *Arthur S. Iberall* to direct the newly formed Research and Development dept., Aircraft Div., has been announced by Aro Equipment Corp.

Maynard D. Church, consultant for the *Worthington Corp.*, has announced his retirement after 29 years of association with the company.

Three executive promotions have been announced by Chrysler Corp. *E. C. Quinn*, vice president and general manager of the Chrysler Div., was elected



In this demonstration, two new grinding wheels were used, one on the hot-rolled steel block, the other to grind the silicon carbide brick. Wheel grade, feed, speed and other conditions were the same. After six minutes, there were shallow cuts of the same average depth in each piece. But nearly half the grinding wheel used on the silicon carbide had disappeared! (Actually, only a diamond wheel can cut silicon carbide refractories). Expressed another way, this means *you would be able to grind all the way through several steel blocks like this* before the #2 wheel would be reduced to the size of the #1 wheel.

arder than steel, more abrasion-resistant than paving blocks — silicon carbide is...

so hard it wears out grinding wheels

As hard as steel is, it can't compare with our silicon carbide efractories (trademarked CARBOFRAX®). Used under the oughest abrasion conditions known, these refractories have epeatedly proved able to outwear other normally durable ining materials. *This applies to room-temperature applications as well as to others ranging up to 3000 F, or more.* It pplies to abrasion caused by rubbing or sliding, and to brasion caused by impingement of sharp particles traveling at high velocities.

For example: In cyclone dust collectors where there is a onstant blast of highly abrasive particles . . . in coke chutes nd hoppers that must withstand punishing cascades of harp-edged coke . . . in hot blast mains where abrasive dust s entrained in high-velocity gases . . . in billet heating furnaces where metal slabs are dragged across the floor. In hort, wherever other materials need replacement so often as to make their use uneconomical.

Have you any spots like these; areas highly vulnerable to abrasion? Then check on these CARBOFRAX refractories. Available as tile, brick or special, close-tolerance shapes, these materials can give your equipment "armor-plate" protection. They are particularly valuable where heat or chemical action may be teamed with abrasion. Write for our booklet that describes all the interesting properties of this and other unique super refractories. No obligation, of course.

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News Digest

News of Engineers (cont.) . . .

president of the Division; *I. T. O'Brien* was appointed to the executive staff of the president in addition to continuing his present duties of supervision of general production and subsidiary operations, and *Fred. J. Lamborn* was appointed a special consultant to the president in addition to continuing his duties as vice president and general manager Dodge Div.

Francis B. Herlihy, formerly assistant chief metallurgist, has been appointed chief metallurgist of the American Brake Shoe Co.

L. E. Grubb, former general superintendent of International Nickel Co.'s Bayonne, N. J., Works, has been named general superintendent of the Huntington, Va., Works. *P. H. Flynn,* who has been assistant superintendent at Bayonne, succeeds Mr. Grubb.

Three new appointments have been announced by Boston Woven Hose & Rubber Co.: *Donald Johnston* becomes manager of hose development; *Edward E. Stritter* takes over as plastics development manager; *William E. Wells* heads the belt development div.

Albert M. Stover, formerly manager of Marvinol plastics development, has been appointed assistant to the director of research and development of the Naugatuck Chemical Div., U. S. Rubber Co.

S. Floyd Stewart has been named assistant to the President at Jack & Heintz, Inc.

William D. Canan, chief mechanical engineer of The Rust Engineering Co., has retired after 28 years of service to the company.

J. B. Buckley has been named vice president at the New Bedford Div., and *Alexander N. Aird* at the Baltimore Div. of Revere Copper and Brass, Inc.

R. Paul Toeppen has been elected vice president of the James H. Knapp Co.

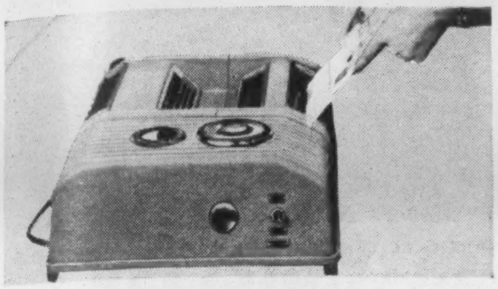
Sharon Steel Corp. has announced the promotion of *James A. Roemer* and *John J. Kraus* to vice presidents of the corporation.

Edward S. Allen has joined the staff of Industrial Systems, Inc. as chief design engineer.

H. Thomas Hallowell, Jr., president of Standard Pressed Steel Co., recently received the annual Achievement Award of the National Metal Trades Assn. for individual and corporate leadership in industrial relations.

Dr. T. Howard James, research associate at Kodak Research Labs., has been awarded a Davanne Medal by the French Photographic Society. Two other Kodak research workers overseas also received Davanne Medals. They are: *Dr. G. I. P. Levenson,* Kodak Limited Re-

Remington Rand Methods News



With Transcopy, one unit does the whole job – exposes, develops and prints.

Photocopies in Seconds, Made in Your Own Plant

How many dozens—or hundreds—of times have you wished you could have a copy of needed data *immediately*, without waiting for it to be typed or traced or sent to an outside service for photocopying? Now you can have photocopies in seconds, made right on your own premises, of customer orders, bills of material, drawings, etc., by either of these two methods:

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Two! Portagraph, Transcopy

If you now have a Remington Rand Portagraph or other device for exposing photocopies, there's a second Transcopy model that will team up with it to save time on the total job and eliminate messy, space-wasting developing equipment. Many users have chosen this combination of equipment because Portagraph can copy from opened booklets, pamphlets, etc., making it unnecessary to detach individual sheets. Ask for folder **P-334.**

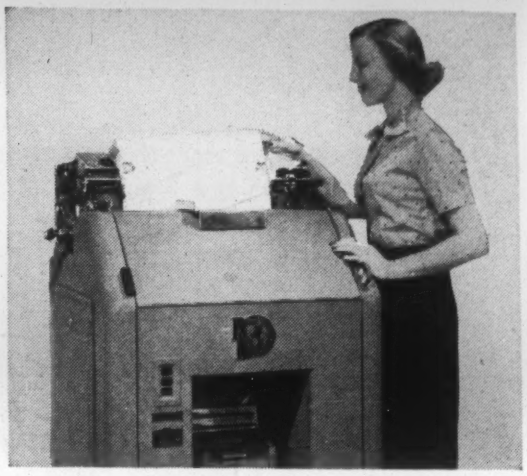
ATT'N: PURCHASING DEPT.

Thousands of copies of Remington Rand's authoritative, fact-packed manual "Purchasing Procedures" have already been furnished to factory executives responsible for or interested in efficient procurement procedures. Would *you* like a free copy? One or more of the scores of ideas presented may be just what you've been needing to speed up paperwork routines and establish closer control. Ask for **X-1202.**

"Tailor-Made" Production Control With Firm—But Flexible—New Methods

Your production problems may very well be similar, overall or in part, to those of The Rotary Lift Company, Memphis, Tennessee. Some of their products, including hydraulic auto lifts, are reasonably standard. But most of their production consists of devices made to highly individualized customer specifications.

With all the variables encountered in manufacturing complex mechanisms on a one-of-a-kind basis, you might think it would be practically impossible to maintain a firm, effective system of production control . . . one that could assure economical coordination of manpower, machines and materials on every order going through the factory.



Complete, tabulated reports automatically prepared by this Remington Rand machine help the Rotary Lift Company control their production effectively and economically.

A workable system was found, however, in a combination of Remington Rand methods and equipment. Punched cards are utilized for high speed preparation of payrolls, and as a by-product, material and labor distribution. In addition they permit rapid, mechanical tabulation of reports valuable to Production, Purchasing Engineering, Accounting and Management executives. Facts on which to base decisions are now available in a fraction of the time previously required.

Tied right in with the Remington Rand punched-card systems are two Remington Rand visible record systems. One of these uses punched cards as inserts in Sched-U-Graph control boards for visible charting of machine loading. Job assignments and changes in schedule are made quickly, easily, with virtually no possibility of oversight or error.

Kardex, another visible system, provides for convenient recording of information supplied by punched-card Material Requisitions, and maintains an effective perpetual inventory control.

The systems flexibility you need in controlling complex, "tailor-made" production, can certainly be found in adaptations of the punched-card principle, visible record principle, or both, depending on the nature and scope of your factory operations. Remington Rand production control specialists will be glad to make specific suggestions without obligating you in any way, whenever you're ready. But in the meantime, why not read the detailed story on the Rotary Lift Company's complete, coordinated system? Mail the coupon for free copy of **CR 801.**

It's Here! A Completely Descriptive, Low-Priced Bookkeeping Machine

Now, for about one-third the price you'd have had to pay for a "big" descriptive bookkeeping machine, you can have the same, basic time and work-saving advantages. It's a simple machine, easy to operate with its touch-method keyboard, and you can use it for any kind of work—payroll, job costing, inventory, receivables, payables, general ledgers, and many special jobs. It gives you simultaneous posting of all records, complete typewriter description of entries, and complete figurework. You can get five or more totals for posting, distribution and control (up to 140 digits of totals). Ask for demonstration locally or mail coupon for free folder **AB-664.**

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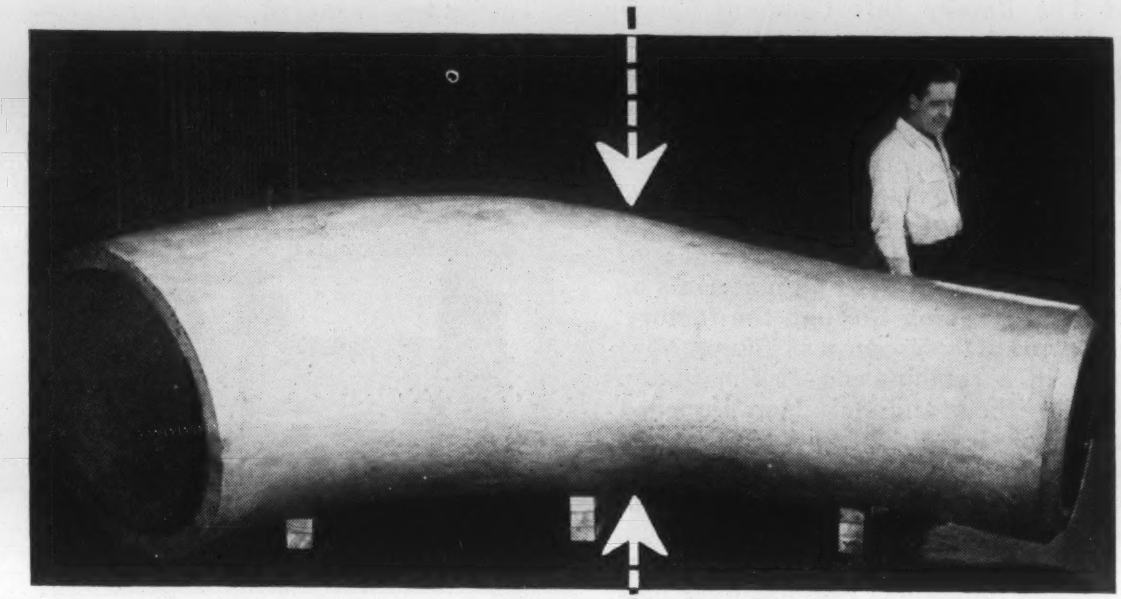

DURALOY

This Casting Set a Record!

Casting weight
21,000 pounds

Shipping weight
14,000 pounds

Alloying Elements
38% Ni., 18% Cr., 2% Mo.

It's the weight rather than the Ni-Cr content that's the record.

We've cast many a piece with such a high Ni-Cr combination. But this represents the largest casting we have ever made. And it took careful scheduling of our entire battery of electric furnaces, with a double melt from two smaller furnaces.

Next followed a thorough X-ray for hidden flaws with our 400,000 volt unit. Then rough-finishing to specifications.

The significant fact is that this casting, the first of this size we have ever produced and destined for a most important high priority processing job, passed inspection with flying colors. *There was no reject here.* It is indicative of the skill of our metallurgists and foundrymen in turning out high alloy castings.

If you are looking for this kind of service, make Duraloy your casting source.

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METAL GOODS CORP: Dallas • Denver • Houston • Kansas City • New Orleans • St. Louis • Tulsa

search Laboratory, Harrow, Eng., and *Mlle. A. M. Venet,* Kodak Pathe Research Laboratory, Vincennes, France.

Murray N. Fairbank has been named manager of product design and engineering, Polaroid Corp.

H. M. Harper Co. has announced the appointment of *Tom Stott* as vice president.

James C. Hicks has been appointed director of refractory research for Kaiser Aluminum & Chemical Corp., and *Arthur H. Branstad* has been appointed manager of the company's fabricating plant. *David Mayers* succeeds Mr. Branstad as works manager at the Trentwood, Wash., rolling mill.

Chase Donaldson has been elected president of East Coast Aeronautics, Inc., a subsidiary of Barium Steel Corp.

Edward L. Ryerson has retired as chairman of the board of Inland Steel Co. *Clarence B. Randall,* formerly president, was made chairman, while continuing his duties as chief executive.

Paul A. Roush, senior project engineer at Flexible Tubing Corp., has been named manager of product development for the company.

The elections of *Don G. Mitchell* as chairman of the board and of *H. Ward Zimmer* as president of Sylvania Electric Products, Inc. have been announced.

Election of *Lysle B. McKinley* as vice president in charge of scientific instrument sales and of *Carl A. Day* as vice president in charge of manufacturing, has been announced by Bausch & Lomb Optical Co.

John S. Dawson was named a vice president of Bridgeport Brass Co.

Firth Sterling Inc. has announced the appointments of *Robert J. Steele* as general superintendent of the Carbide Div., and *John D. Knox* as superintendent of the Powdered Metals Div.

Jerold L. Welch has been named assistant chief engineer, Reed-Prentice Corp.

Paul A. Metzger has been appointed to the newly created position of materials manager at Servel, Inc.

The American Safety Razor Corp. has announced the appointments of *Donald D. Mallory* as director of engineering and *Wayne M. Biklen* as manager of quality control.

Howard D. Neal, general manager of Aerol Co., has been promoted to the office of vice president and general manager of the company.

Marsch B. Hall has been named chief engineer and *Willard S. Collins* assis-

No. 120 of a Series of Typical Installations

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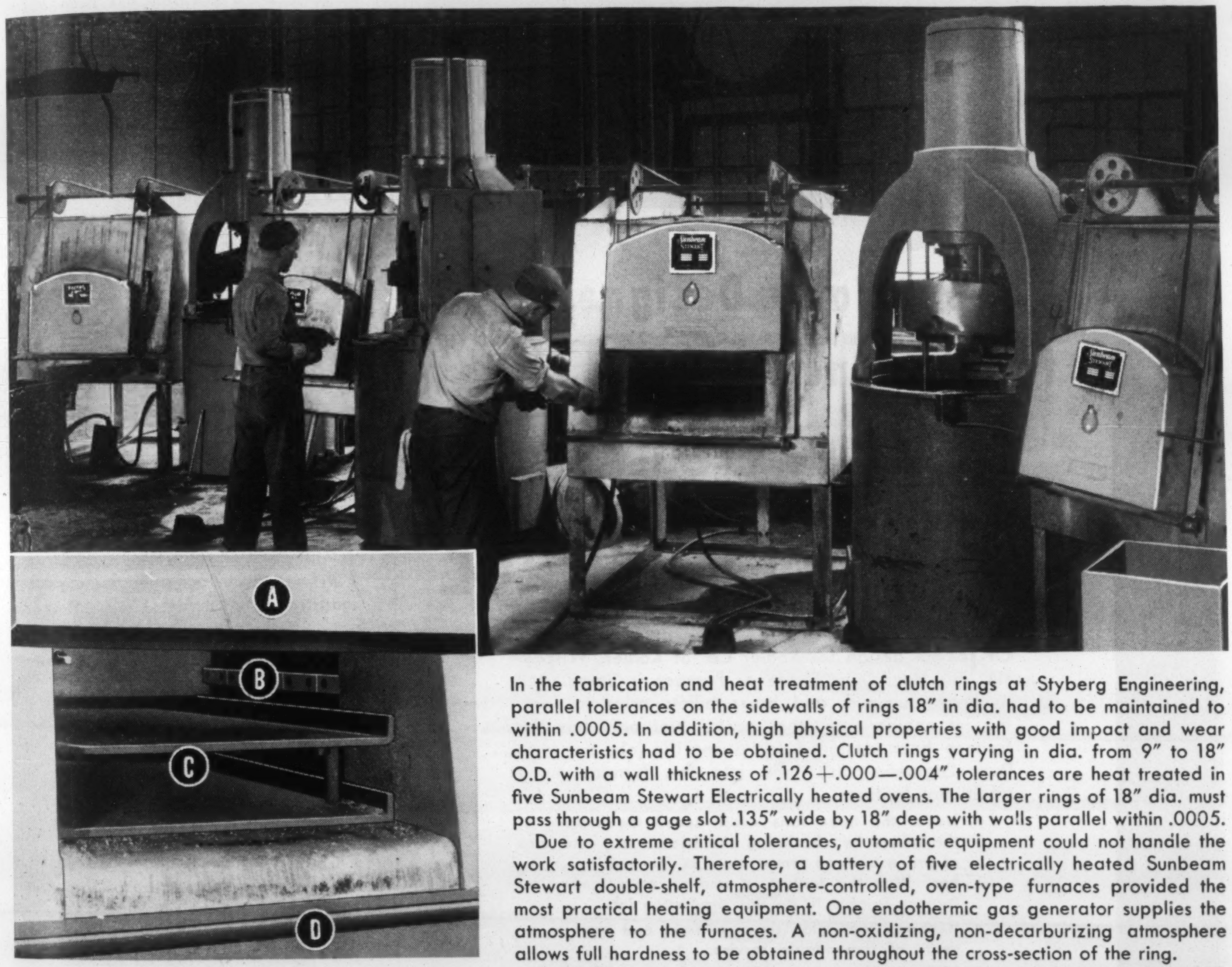
THE BEST INDUSTRIAL FURNACES MADE

HOW SUNBEAM INDUSTRIAL FURNACES MEET THE DEMANDS ON THE PRODUCTION FRONT

PRECISION HEAT TREATMENT OF CLUTCH RINGS

AT STYBERG ENGINEERING CO., Racine, Wisc.



Close-up view of double shelf hearth area. A. Patented Seal-tite door provides a positive seal that prevents infiltration of air into the heating chamber. B. Heating elements on 4 sides of chamber assures close temperature control and even heat distribution. C. Two shelves of 2812 alloy, one containing work at hardening temperature; the second, with work being brought up to temperature. D. Flame curtain decreases infiltration of air into heating chamber and ignites escaping atmosphere.

In the fabrication and heat treatment of clutch rings at Styberg Engineering, parallel tolerances on the sidewalls of rings 18" in dia. had to be maintained to within .0005. In addition, high physical properties with good impact and wear characteristics had to be obtained. Clutch rings varying in dia. from 9" to 18" O.D. with a wall thickness of .126+.000—.004" tolerances are heat treated in five Sunbeam Stewart Electrically heated ovens. The larger rings of 18" dia. must pass through a gage slot .135" wide by 18" deep with walls parallel within .0005.

Due to extreme critical tolerances, automatic equipment could not handle the work satisfactorily. Therefore, a battery of five electrically heated Sunbeam Stewart double-shelf, atmosphere-controlled, oven-type furnaces provided the most practical heating equipment. One endothermic gas generator supplies the atmosphere to the furnaces. A non-oxidizing, non-decarburizing atmosphere allows full hardness to be obtained throughout the cross-section of the ring.

These Sunbeam Stewart furnaces are designed to provide high heat input with low wall losses. This is ideally suited for production requirements as extremely rapid recovery of the furnace to the control temperature occurs upon loading cold work. Rapid return to temperature reduces waiting time, allowing a larger, steadier production. Because of its wide operating range, this Sunbeam Stewart unit is ideal for general purpose heat treating including hardening of carbon and alloy steels, normalizing, annealing, and pre-heating high speed steels, etc.

IF YOU ARE CONSIDERING DEFENSE WORK CALL SUNBEAM. Designs are available for heat treating the following materiel:

SHELLS: 57MM; 75MM; 90MM; 105MM; 120MM; 155MM; 3", 5", 6", 8" Navy Shells (Harden, Quench and Draw).

FORGINGS: Rotary Hearth and Pusher-type Forging Furnaces.

ARMOR PIERCING SHOT (Harden, Quench and Draw).

CARTRIDGE CASES (Anneal, Stress Relieve).

MACHINE GUN CLIPS (Harden, Quench and Draw).

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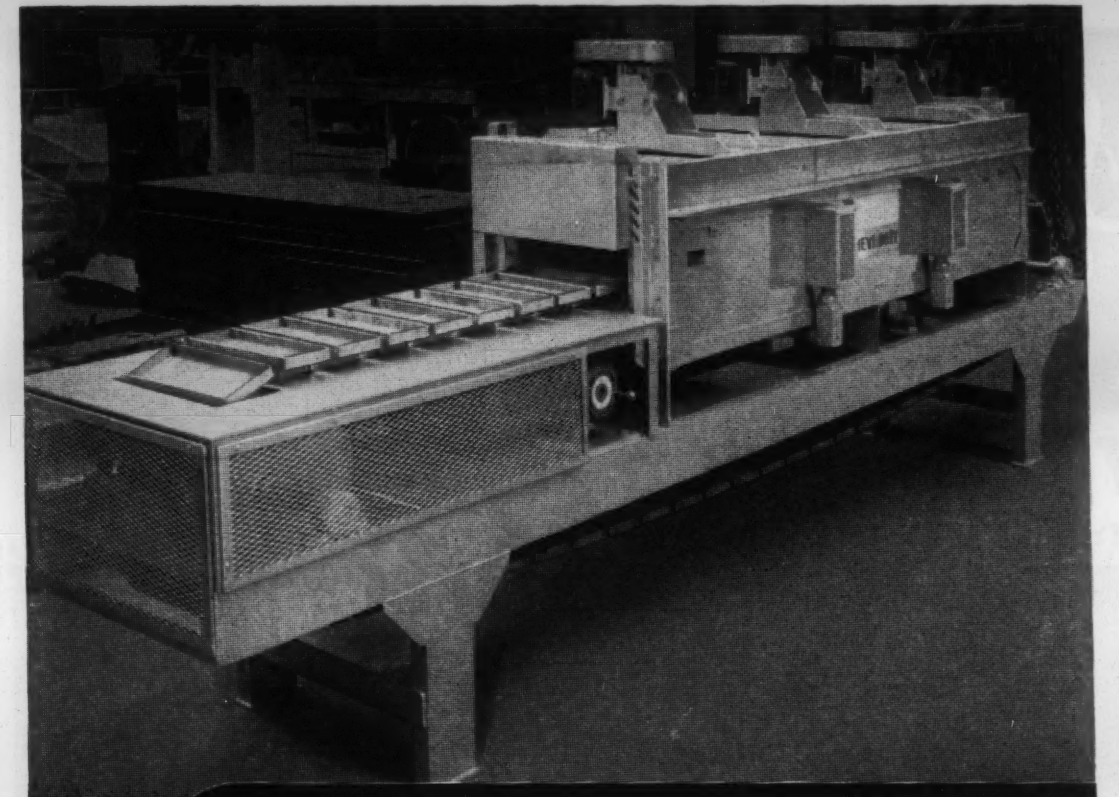
Canada Factory: **321 Weston Rd., Toronto 9**

A letter, wire or 'phone call will promptly bring you information and details on SUNBEAM industrial furnaces, either units for which plans are now ready or units especially designed to meet your needs. Or, if you prefer, a SUNBEAM engineer will be glad to call and discuss your heat treating problems with you.



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CONVEYOR FURNACE

Of special design for Kohler Co. of Kohler, Wisconsin, this Hevi Duty Conveyor Furnace is being used to heat aluminum and brass billets prior to forging jet engine and other parts. Not only has this furnace been designed for a specific job, but Hevi Duty Engineers also built into this furnace many additional features.

- **Notice the three fans which speed the heating of the billets by circulating the heated air, and also assure a uniform temperature in the heating chamber. With this feature, a smaller, more economical furnace is able to do this production job.**
- **Heat resistant alloy conveyor links and trays mean years of dependable service.**
- **Versatility . . . by using a variable speed drive to adjust the conveyor speed, this furnace can be used for annealing, tempering, and other heating operations.**

Special Hevi Duty Furnaces can be engineered to your specifications and your production system. Let us know your requirements. Our engineers will work with you.

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Heat Treating Furnaces . . . Electric Exclusively
Dry Type Transformers *Constant Current Regulators*

News Digest

News of Engineers (cont.) . . .

tant chief engineer of the Development and Research Engineering Dept., Acme Steel Co. Mr. Hall replaces *James N. Wognum* who was recently named chief engineer of Acme's newly created Engineering Research Lab.

J. B. Ribakoff has been named a vice president of Solar Steel Corp.

John D. Thompson has been elected executive vice president of Henry Disston & Sons, Inc.

H. C. Yaeger has been named production manager at Jacobs Aircraft Engine Co., a subsidiary of Barium Steel Corp.

Franz F. Kaiser has been named chief industrial engineer at Fairbanks, Morse & Co.

John B. Florence has been appointed chief engineer of James H. Knapp Co.

Atlantic Casting & Engineering Corp. has announced the addition of *George H. Binns* to its staff as engineer.

Election of *Dr. H. N. Stephens* as vice president in charge of central research has been announced by Minnesota Mining & Manufacturing Co. Dr. Stephens has been in charge of the central research laboratory since 1937.

Colorado Fuel and Iron Corp. has announced the appointments of *William Brill* as director of engineering and *Dean B. Valentine* as assistant superintendent of industrial engineering.

Tube Reducing Corp. has announced the appointment of *D. R. Strouse* as production manager.

Robert F. Smith, vice president of The Indiana Steel Products Co., and acting chief executive of the company for the past several months, has been elected president of the company and a member of the board.

Cooper Alloy Foundry Co. has announced the appointments of *Anthony A. Miano* as standards supervisor, Stainless Engineering & Machine Works Div., *John L. Keating* as production manager, and *Morton L. Katz* as chief shell mold engineer.

Charles B. Spencer, president, Spencer, White & Prentis, has been named as this year's winner of the Egleston Medal, top honor of Columbia University's Engineering Alumni Assn.

The election of *Thomas D. Cartledge,* president of Linde Air Products Co. and director and president of Dominion Oxygen Co., Ltd., as vice president of Union Carbide and Carbon Corp., has been announced. Election of *Howard S. Bunn,* president of Bakelite Co., and director and president of Bakelite Co. (Canada) Ltd., a director of Bakelite Ltd. (England), and a director and vice president of Canadian Resins and Chem-

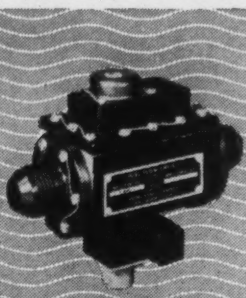
Revere INSTRUMENTS HAVE A RECORD OF TOP PERFORMANCE IN TOP AIRCRAFT

Revere control instruments have shared the responsibility and achievements of the aircraft industry since 1939 with years of dependable performance under all types of weather conditions. Today Revere is recognized as one of the foremost producers of precision instruments. You'll find them installed in many world-famous airplanes.

Extensive research and development facilities coupled with precision production methods contribute immeasurably to Revere's reputation for highest quality control instruments. Contact Revere's field engineering department today. Let qualified engineers assist you with your liquid or electro-mechanical control problems . . .

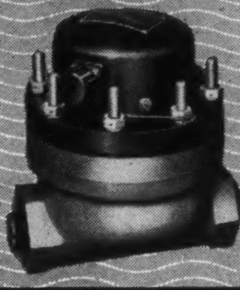
FUEL FLOW SWITCH

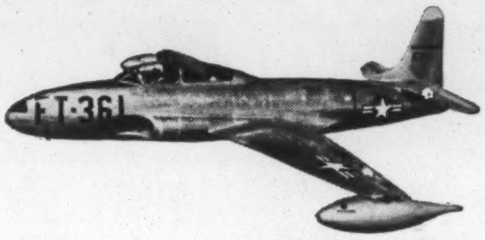
Specially designed by Revere for use in the auxiliary fuel line of the McDonnell F2H-3 twin-jet, carrier-based fighter. This instrument transmits a warning signal whenever fuel flow falls below a pre-determined value. *Send for Bulletin No. 1400*



FUEL FLOW TRANSMITTER

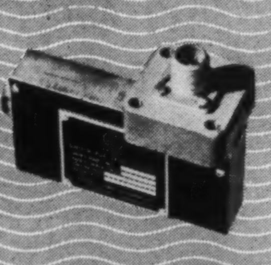
The Revere Fuel Flow Totalizer is an integral part of the fuel system. It records the rate of fuel flow in the T-33's jet engines. The flow totalizer can be used on piston engines, diesels or test stand operations. *Send for Bulletin No. 1300*





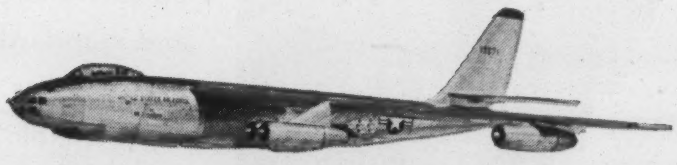
LIQUID LEVEL SWITCH

Republic's F-84G Thunderjet, first USAF fighter-bomber to refuel in mid air, has Revere's Liquid Level Switches installed in their fuel tanks. This hermetically-sealed, magnetically actuated switch presents a new standard of safety. *Send for Bulletin No. 1100*



FLOAT SWITCH

Boeing's B-47 Stratojets have Revere Float switches installed in all fuel tanks to maintain high-level fuel control. These switches can be furnished with single or dual float systems with levels set at the factory. *Send for Bulletin No. 1200*



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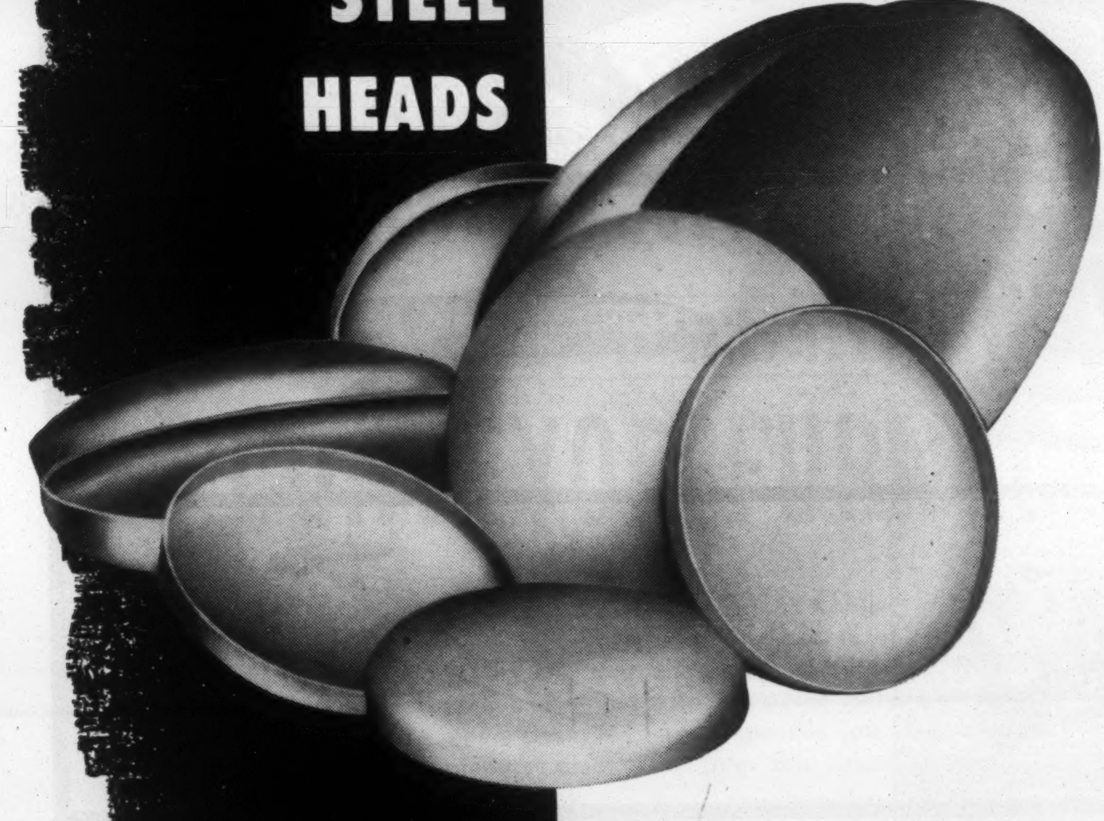

"Heads-up" Service in STAINLESS STEEL HEADS

Fabricators rely on G. O. Carlson, Inc. for stainless steel heads produced to exact specifications and for other components of stainless steel tanks. Shells, flanges, rings, pads as well as spun or press-formed heads are readily available as a packaged service. This eliminates the need of multiple ordering from several suppliers and places responsibility in the skilled hands of Carlson specialists.

Carlson stainless steel heads are produced in a wide range of sizes and gauges to ASME and standard specifications. Many styles of forming dies are available. There's an up-to-date folder describing these dies—write for your copy now!

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THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

News Digest

News of Engineers (cont.) . . .

icals Ltd., as vice president of Union Carbide has been announced.

At a recent directors' meeting, *Earle W. Couch* was elected president and treasurer of Lea Manufacturing Co. to succeed *Robert S. Leather* who was named chairman of the board. *Richard P. Crane* was named vice president.

Albert E. Forster was elected president of Hercules Powder Co. and also chairman of the executive committees. Mr. Forster succeeds *Charles A. Higgins*, who plans to retire.

J. H. Kelley, assistant superintendent, open hearth and bessemer dept., Sparrows Point, Md., Plant, Bethlehem Steel Co., was awarded the American Iron and Steel Institute Medal for a paper of special merit in connection with the activities of the iron and steel industry. *Hobart M. Kraner* and *Charles N. Jewart*, also of Bethlehem Steel, were each given the Regional Technical Meeting Award of the Institute. The awards, in stainless steel, were given for co-authorship of a paper on "Heating-Up Open Hearth Furnaces After Rebuilding".

General Electric Co. has announced the following appointments: *Karl R. Van Tassel* as general manager of the Knolls Atomic Power Lab.; *Donald L. Millham* as vice president and general manager of the Lamp Div.

Erhardt C. Koerper has been named works manager of Ampco Metal, Inc.

Minnesota Mining & Mfg. Co. has announced the promotion of three members of its Central Research Dept. *Dr. Matthew W. Miller* was named business manager, and *Dr. Alvin M. Borders* and *Dr. Harold M. Scholberg* were named associate directors of the department.

Baldwin-Lima-Hamilton Corp. has announced the following changes in its officers: *J. F. Connaughton*, formerly general manager of the Hamilton Div., was elected vice president in charge of the Eddystone Div.; *Perry A. White*, formerly controller of the Eddystone and Hamilton Divs., was elected general controller of the company to succeed *W. Raymond Parshall*, who has resigned.

Carl H. Morken, formerly works manager of Kennedy Valve Mfg. Co., has been named vice president in charge of manufacturing by the company.

Jerome Ottmar of Metals & Controls Corp. was recently elected vice president of the company.

David MacGregor, chief engineer of Edward Valves, Inc., has been assigned the additional duties of works manager. Mr. MacGregor will supervise all manufacturing operations and industrial relations.

Knapp Mills Inc. has announced the election of *Harold E. Olson* to a newly

For the long haul... Autocar relies on RB&W bolts

Famous truck builder rates them best for ease of assembly and accessibility

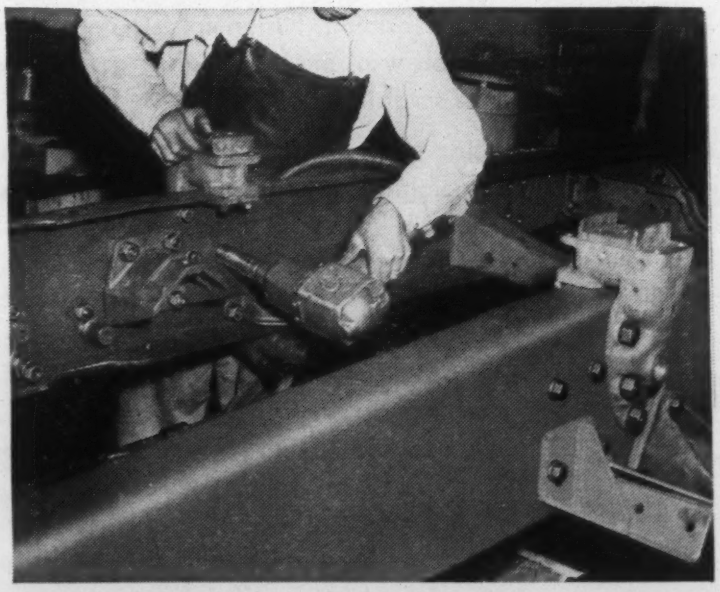
It's been a long time since the Autocar people switched from riveted to bolt-and-nut construction. Here's how it happened:

Two Autocar engineers took off on a coast-to-coast run to shake the bugs out of a new test model. Things went well until a riveted spring bracket broke. It took an entire day just to chisel through the rivets because it was hard to get at the bracket.

From that day on, it was *accessible* bolt-and-nut construction exclusively for all Autocar trucks. And Autocar standardized on RB&W bolts. One dividend from using these rugged bolts is that Autocar can specify higher-strength material than is practical for riveting. Furthermore, tests on structures like bridges show that rivets frequently loosen. This doesn't happen to bolts on Autocar frames.

Where you want to join structural members firmly together so they'll *stay* together for good, high-strength bolting is often your best bet.

As the leading manufacturer of all kinds of fasteners, we're in the unusual position of always being able to recommend and supply the right ones for all your needs. Write to RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY, Port Chester, N. Y.



FASTER FASTENING is achieved in the Autocar plant at Ardmore, Pa., by using air tools like the one shown here to run up RB&W nuts on RB&W bolts on an Autocar truck frame. In addition to making tight, accessible joints, bolting effects substantial assembly savings.

3.1

RB&W

108 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

Plants at: PORT CHESTER, N. Y., CORAOPOLIS, PA., ROCK FALLS, ILL., LOS ANGELES, CALIF. *Additional sales offices at:* PHILADELPHIA, PITTSBURGH, DETROIT, CHICAGO, DALLAS, SAN FRANCISCO. *Sales agents at:* PORTLAND, SEATTLE. *Distributors from coast to coast.*

IF YOU'RE BENT ON CUTTING COST CORNERS . . .

Fusionweld

STEEL TUBING
IS ECONOMICAL and QUALIFIED

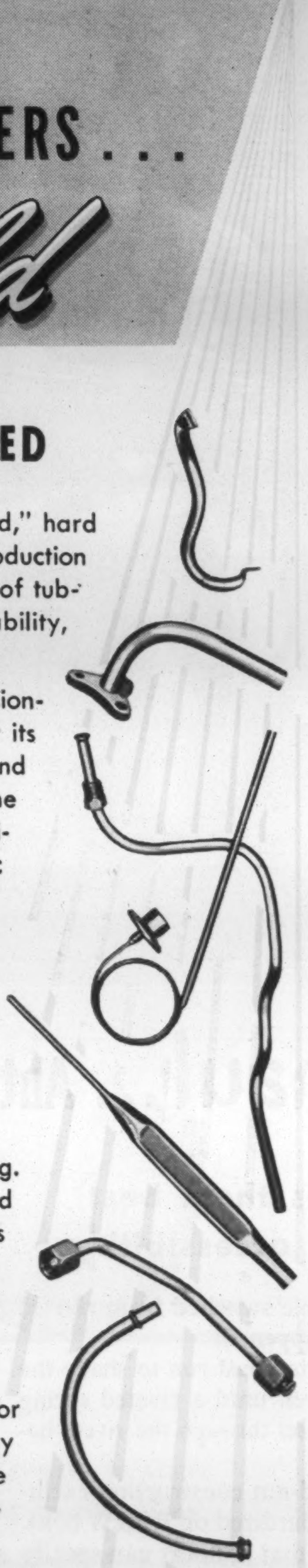
HERE'S WHY! Avon thin wall steel tubing—"as welded," hard drawn, or soft annealed—cures plenty of cost and production headaches . . . has successfully supplanted other types of tubing—copper, aluminum, brass and steel,—where reliability, performance and price *all* meet at the cross roads.

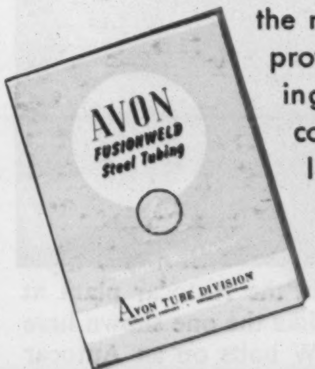
Hundreds of diversified manufacturers specify Avon Fusionweld Steel Tubing for its clean, smooth O. D. . . . for its tensile strength, greater resistance to vibration and fatigue . . . extreme ductility and adaptability to the toughest tube forming operations . . . and for its hi-pressure tested advantages in hydraulic and pneumatic applications.

Avon engineers can assist you in cutting cost angles—whether its in tubing by the coil, or by the car load.

HERE'S HOW! Avon Fusionweld is produced by our own exclusive, hi-cycle, resistance welding methods to provide tubing of superior quality to serve the most critical needs for bending, beading, flaring, coiling, slotting, threading, knurling, perforating and swaging. That spells lower cost forming. Fusionweld tubing is held to closer tolerances on wall thickness—that guarantees uniform strength, less scrap loss!

The consistent tubular strength achieved by Fusionweld is due to its unique single wall construction . . . more uniform grain structure in both wall and welded areas. That insures maximum resistance to tearing, cracking or checking at the weld or wall. Its smooth O. D. achieved by the new Fusionweld process likewise provides an ideal surface for plating operations. These features, coupled with approval by the leading testing laboratories, plus a constantly expanding list of prominent tube users is your positive safeguard when specifying Fusionweld—"The Tubing With a Future."





3/16" O.D. to 5/8" O.D. Plain or Terne Coated
We can fabricate tubing forms to your specifications.

AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
ROCHESTER MICHIGAN

News Digest

News of Engineers (cont.) . . .

created post of executive vice president of its wholly-owned subsidiary, Andrews-Knapp Construction Co., Inc.

Walter Lincoln Hardy has been promoted to director of engineering of Foster D. Snell, Inc.

Philip M. Ginder has been elected a vice president, and *George F. Halfacre* has been appointed manager of manufacturing of New Jersey Zinc Co.

Election of *Randolph J. Roshirt* as vice president of Aluminum Industries, Inc., has been announced.

Harold W. Pope, formerly chief engineer at Convair's Guided Missile Div., has been elected the 14th associate of Sanders Associates, Inc., Nashua, N. H., and is taking over direction of its guided missile and aero-mechanical activities.

Carl J. Westling has been appointed director of engineering for Salem-Brosius, Inc.

Dr. William R. Veazey, long identified with research and administrative activities of Dow Chemical Co., has retired after 37 years of service, including 26 years as a board member.

Major General Edmond H. Leavey, U.S.A. (Retired), has been elected president of Federal Telecommunication Labs., Inc.

Dr. C. L. Clark, metallurgist at The Timken Roller Bearing Co., is the author of a new book entitled, "High Temperature Alloys".

W. E. Benninghoff has been elected to the post of vice president of Ohio Crankshaft Co. Mr. Benninghoff will continue to serve as general manager of the company's Tocco Div.

Promotion of *Henry S. Curtis* to the post of manager of production and engineering at the Diamond Alkali Organic Chemicals Div., Inc., has been announced.

Thermoid Co. has announced the following appointments: *Carl P. Brockway* as president and director of its subsidiary, Asbestos Mfg. Co.; *A. K. Runkle* to the post of superintendent of the Friction Div.

Rosedale Foundry & Machine Co. has elected *Charles H. Evans* and *Paul H. Magnus, II*, as vice presidents.

Election of *E. M. Swartz* as vice president, U.S. Radiator Corp., has been announced.

W. Tom Moore has been named an executive assistant in the Atomic Power Div., Babcock & Wilcox Co.

Karl P. Goodwin has been elected vice president and director of sales, Rubber Div., Acushnet Process Co.

Four new assignments in the Research and Development Dept., Naugatuck Chemical Div., U.S. Rubber Co., have

News of Engineers (cont.) . . .

been announced: *Dr. W. F. Tuley* was appointed group manager of product development and technical sales service; *Dr. L. H. Howland*, manager of synthetic rubber development; *Dr. P. M. Elliott*, manager of plastics development; and *F. L. Holbrook*, manager of rubber chemicals development. U.S. Rubber Co. has also announced the appointment of *Chester F. Noonan* as vice president and general manager of the footwear and general products div. *Eugene A. Luxenberger*, assistant production manager, will succeed Mr. Noonan as assistant general manager of that division.

Carl F. Mayer was one of four recipients of the annual Trinks Award for outstanding achievement in the industrial heating industry.

H. H. Gorrie, assistant chief engineer of Bailey Meter Co., has been appointed chief engineer of the company.

Harry C. Slagle, manager of Aluminum Co. of America's Chicago Works, has been transferred to Pittsburgh as manager of the company's shop training program. Mr. Slagle will be succeeded by *R. E. Sheffer*, staff assistant to the general manager of the Fabricating Div.

Allied Products Corp. has announced the appointment of *John F. Haller* as vice president in charge of engineering of the company, and of *Eugene F. Wambold* as vice president and general manager of Michigan Powdered Metal Products Co., Inc., a wholly-owned subsidiary.

Dr. S. L. Hoyt has retired as technical advisor at Battelle Memorial Institute to engage in consulting practice. Dr. Hoyt's new headquarters will be at 32 Blenheim Rd., Columbus 14, Ohio.

Gordon Grand, Jr. has been elected assistant to the president, Olin Industries, Inc.

John V. Moran, Jr. has been appointed head of the Special Publications Section, International Nickel Co., Inc., to succeed the late *Edward C. Badeau*. Mr. Moran had been an assistant to Mr. Badeau for the past two years. *J. Roy Gordon* has been elected vice president and general manager of Canadian operations of the International Nickel Co. of Canada, Ltd., succeeding the late *R. Leslie Beattie* in both capacities.

Sylvania Electric Products, Inc. has announced the appointments of *E. Finley Carter* as vice president and technical director of the company, and of *Howard L. Richardson* as vice president in charge of engineering operations.

E. C. Clark, assistant director of the Research and Engineering Dept., Air Reduction Sales Co., has been appointed director of operations. *L. B. Dobbins*, works manager of Airco's liquid oxygen plant at Butler, Penna., has been appointed

MUELLER BRASS CO.

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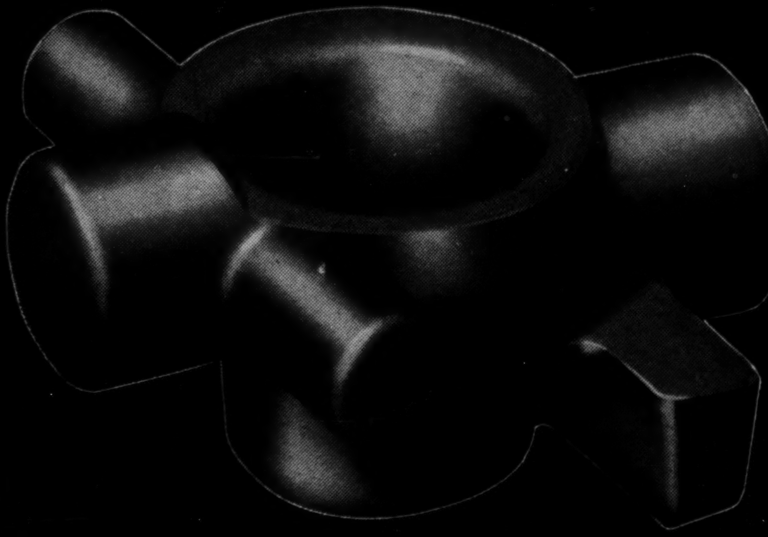
AND ALUMINUM



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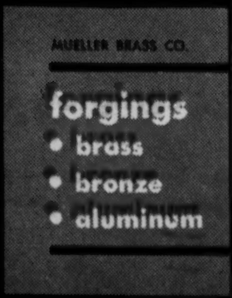

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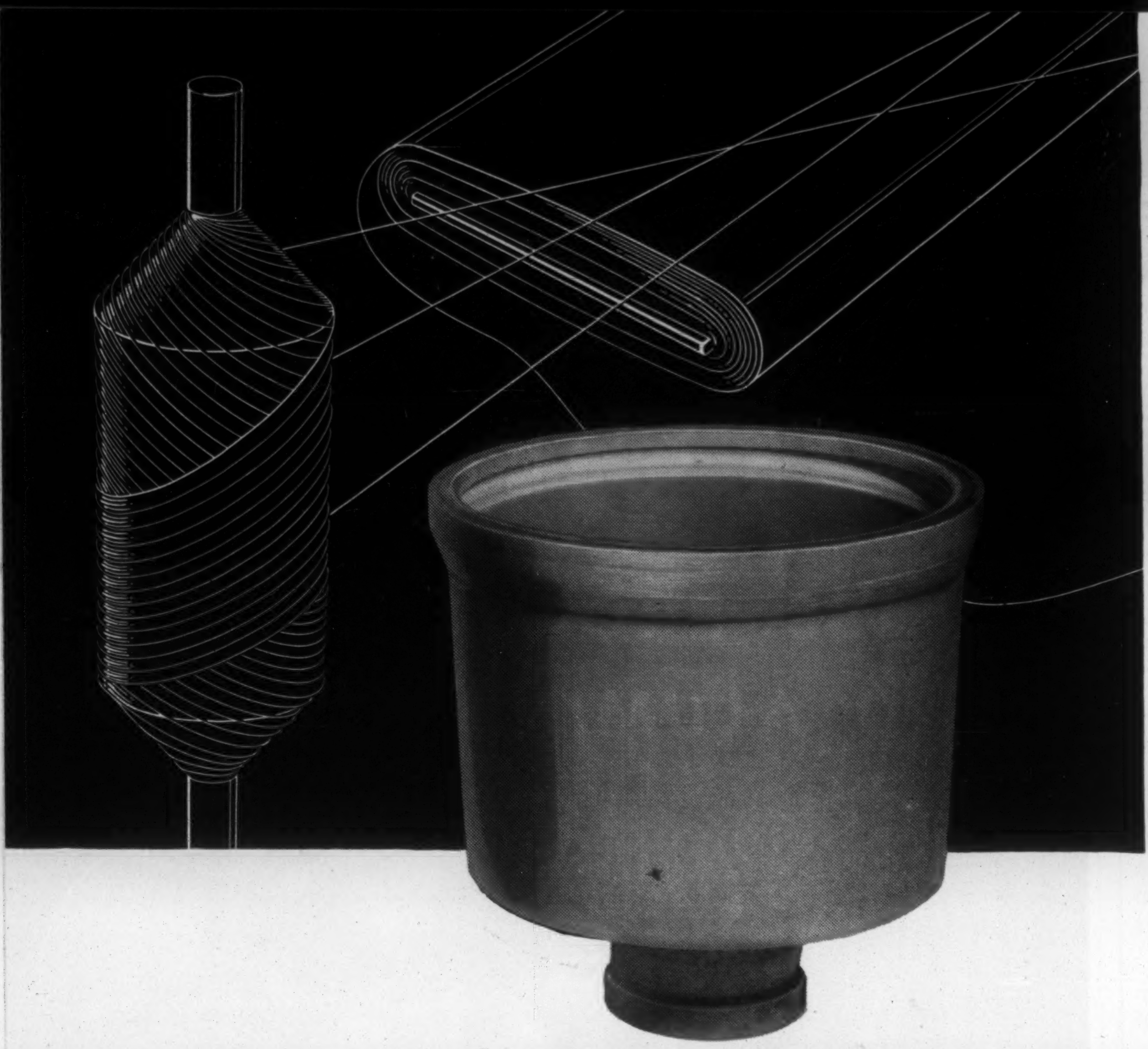

Here's what micarta® LAMINATED PLASTICS is doing for textile production!

A leading textile manufacturer wanted a material for spinning buckets that would resist acids and withstand vibration at all operating speeds. MICARTA proved to be the answer. From this manufacturer the use of MICARTA has spread to textile mills all over the world.

What can Micarta do for you?

You may be looking for a material that won't snag or cast off contaminants on expensive spinning runs. Perhaps you need something light, strong and able to stand up to repeated shocks or corrosion or abrasion. Whatever your problem is, there's an excellent chance that the answer lies in MICARTA. This versatile material is already solving hundreds of varied textile problems for others. Why don't you take a look at the broad range of MICARTA qualities?

For the complete story on this proven material fill out the coupon below.

YOU CAN BE SURE...IF IT'S Westinghouse

micarta® is basic!

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MICARTA Division, Trafford, Pa.
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Address__________
City__________Zone____State________
J-06513

News Digest

News of Engineers (cont.) . . .

manager of plant engineering, replacing R. E. Lenhard who is being transferred to the Ohio Chemical and Surgical Equipment Div. of the company as vice president-manufacturing.

Air Reduction Co., Inc. has announced that *Dr. John M. Parks* has joined its Research Labs. as manager of the Metallurgical Process Div. Other appointments announced by the company are: *Dr. L. I. Gilbertson* as director in charge of the company's Murray Hill (N. J.) Labs.; *Dr. G. B. Carpenter* as manager of the development staff; *Dr. A. Muller* as director of metallurgical research at the Murray Hill Labs; and *Dr. B. C. Redman* as director of chemical research at the Murray Hill Labs.

William J. Priestley, vice president and director of Union Carbide and Carbon Corp., was recently honored by the Alumni Assn. of Lehigh University with the Lehigh Alumni Award "in recognition of extraordinary achievements in ferrous and nonferrous metallurgy, and of significant services as an iron and steel plant operator. . . ."

S. J. Sindeband has been elected president of the Mercast Corp.

George C. Miller has been appointed president of Bakelite Co. Mr. Miller was formerly vice president in charge of sales. He succeeds *H. S. Bunn* now vice president of Union Carbide and Carbon Corp. and chairman of Bakelite Co.

Paul F. Mumma has been named general superintendent and *William R. McCalister* as assistant general superintendent, Gary Works, National Tube Div., U.S. Steel Corp.

Charles A. Higgins recently resigned as chairman of the board, Hercules Powder Co. He also resigned as a member of the company's finance committee, but remained a member of the board. *Anson B. Nixon,* a vice president, was elected to succeed Mr. Higgins as chairman of the board.

Albert H. Borchardt, vice president of Worthington Corp., has announced his retirement after 44 years with the company.

Election of *Neele E. Stearns* and *William G. Caples* as vice presidents of Inland Steel Co. has been announced. Appointment of *L. B. Hunter* as president of Inland Steel Container Co., a division of Inland Steel, and of *William A. Jahn* as president of Inland Steel Products Co., a wholly-owned subsidiary of Inland Steel Co. have been announced. The two men replace Mr. Caples and Mr. Stearns, respectively.

Died . . .

R. Leslie Beattie, Vice President and General Manager of Canadian Operations

...*and*

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for stainless

When it comes to stainless steel, no one has had broader experience in working out metallurgical, fabrication and application problems than Crucible. Stainless is actually a group of *special* steels. And we have been the world's largest producer of all types of special steels for 53 years.

Our technical staffs and field representatives are available to help you select the grade, size or finish that is most practical and economical for your product or processing operation . . . with due consideration for fabricating problems as well as service use.

Besides our broad technical service, you get as fine a quality stainless steel as is made because Crucible REZISTAL stainless is produced in mills that were built exclusively for producing these corrosion and heat resistant steels.

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53 *years of* *Fine* *steelmaking*

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for zinc,
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And they are easy to
apply! Just a simple chemical dip
for only a few seconds produces the coating.

LOW MATERIAL
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combine to make Iridite the most economical chromate finish you can buy. Many Iridite chemicals are packed in powder form, thus can be shipped to you in steel pails at freight savings of up to 75%! Pails take less storage space, are easier to handle, eliminate carboys, need not be returned.

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for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ARP Plating Brighteners
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News Digest

News of Engineers (cont.) . . .

of The International Nickel Co. of Canada, Ltd.

Edward C. Badeau, in charge of the Special Publications Section of the International Nickel Co., Inc., and Editor of the Inco Magazine.

Francis S. Cenneen, Secretary-Treasurer, and co-founder of The Ohio Crankshaft Co.

Terrence W. Griffin, Treasurer and Secretary of Kensico Tube Co., Inc.

Summer Simpson, Chairman of the Board of Raybestos-Manhattan, Inc.

Gail E. Barr, Superintendent of the Natrona, Penna., Plant, Penn. Salt Manufacturing Co.

Dr. Pierre I. Chandeysson, President and Founder of Chandeysson Electric Co.

Parker Appliance Co. has announced that the operations of its subsidiary, *Synthetic Rubber Products Co.* of Los Angeles, are being merged with those of Parker's Rubber Products Div. Henceforth, the Los Angeles facility will be known as the *Rubber Products Div., Parker Appliance Co.*

News of Companies

Eutectic Welding Alloys Corp. has formed a Canadian company to be known as the *Eutectic Welding Alloys Co. of Canada, Ltd.*

Luria Engineering Co. has received a contract to produce an 18,200 sq ft addition to the present plant of *American Welding & Manufacturing Co.*

The Buffalo, N. Y., branch office of *Thor Power Tool Co.,* will move into a new building at 735 Military Rd., Buffalo.

Metalloid Corp. has announced the opening of a new Chicago office at 753 W. 79th St.

Ground was broken near Pittsburgh recently for *Westinghouse Electric Corp.'s* new factory that will build parts for atomic power plants. This is believed to be the first privately-financed atomic manufacturing plant. The new facility will house the newly-formed *Atomic Equipment Dept., Atomic Power Div.* The company has also announced that it has doubled its capacity for the production of generators and large

OSBORN

14 minutes by hand . . .
Now 3 minutes with push-button brushing

This strip act with Osborn wire brushes is taking off costly hours in the production of d-c motor armatures . . . typical of savings being discovered throughout industry with push-button brushing methods.

The job here is to remove enamel insulation from copper wires to assure top quality soldered connections. Formerly done by a tedious hand-scraping method, the time per armature was 14½ minutes. With the motor-driven brushing device shown the time has been cut to 3 minutes. As the armature is turned, a pair of Osborn Disc Center wire brush heads rotate downward on the wires and the insulation comes off clean.

This is typical of thousands of production jobs which have been simplified with the help of the **O**sborn **B**rushing **A**nalyst. For help to improve *your* cleaning, finishing or deburring operations, call your **OBA** or write *The Osborn Manufacturing Company, Dept.* **N-4,**
5401 Hamilton Avenue,
Cleveland 14, Ohio.

FREE: New booklet on deburring with Osborn Power Brushing. Write for your copy.

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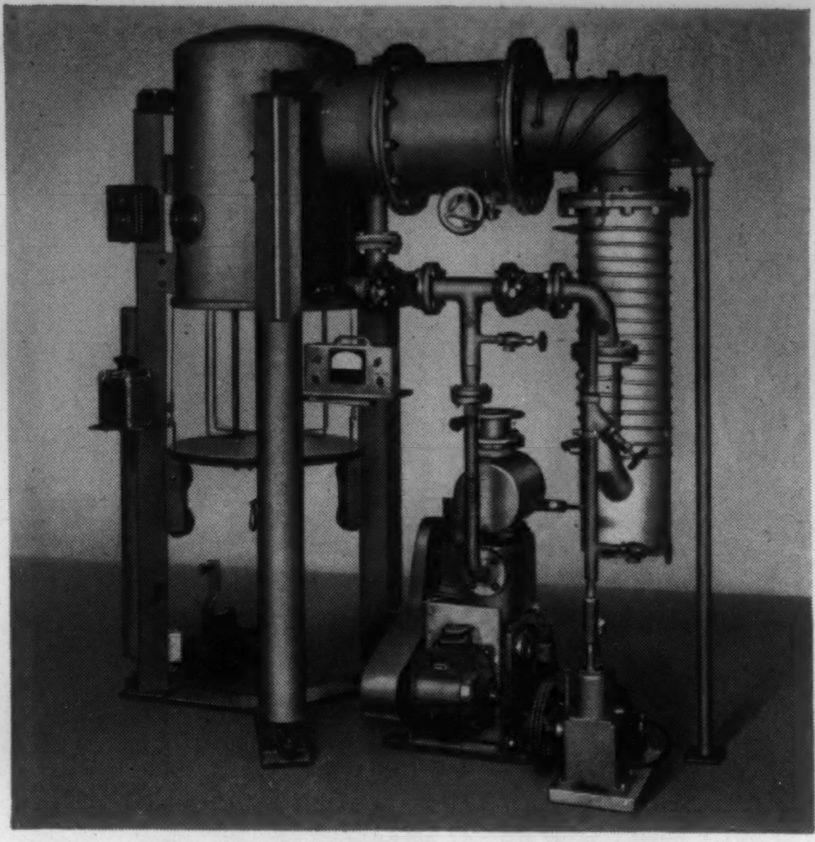
Osborn Brushes

OSBORN POWER, MAINTENANCE AND PAINT BRUSHES AND FOUNDRY MOLDING MACHINES



The new model 3134 National Research Vacuum Coater

VACUUM COATER

$6350*

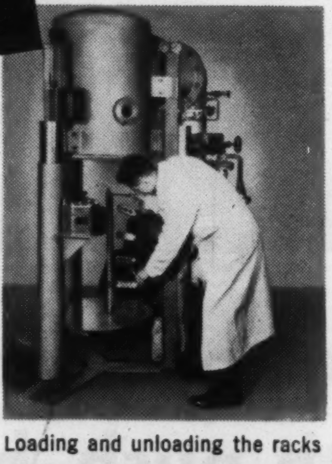
COMPLETE — READY TO OPERATE

for medium production

If your vacuum metallizing production has outgrown the bell-jar stage, here's your answer. A new, low cost coating unit complete with Alphatron® gauging, jigs with manual rotator and filament power supply. It swiftly coats plastics or metal surfaces with a gleaming layer of metal.

Simple to operate. All loading, unloading and operating is done at a single station. Equipped with NRC Rotary Gas Ballast Pumps that maintain initial cfm rate even when pumping water vapor, plus a 10-inch diffusion pump. Pump down time to coating pressure is approximately 4 to 5 minutes with the tank dry and empty. Tank size 24 inches in diameter, 30 inches high. Write for details.

*F. O.B. Newton, Mass.



Loading and unloading the racks

Operating the coater

INDUSTRIAL RESEARCH
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HIGH VACUUM ENGINEERING

NRC

PROCESS DEVELOPMENT
PHYSICS, DEHYDRATION
DISTILLATION, VACUUM COATING

National Research Corporation
EQUIPMENT DIVISION
Seventy Memorial Drive, Cambridge, Mass.

News Digest

News of Companies (cont.) . . .

motors. An expansion program now being completed at the *Transportation and Generator Div.* at East Pittsburgh, Pa., works also provides for future expansion as needed.

Opening of a newly built main plant by *Magnaflux Corp.*, at 7300 Lawrence Ave., Chicago, has been announced. The new plant and main office building comprise 74,000 sq ft, nearly twice the size of the old plant.

DeBell & Richardson, Inc. has announced the formation of a new corporation to be known as *D & R Plastic Welders, Inc.* The function of this company will be to assist those who have fabricating problems requiring the development of specialized welding techniques and materials.

A $750,000 plant for the manufacture of chemical maintenance products for automobile, aircraft, home and industry will be erected in Sunnyvale, Calif., by *R. M. Hollingshead Corp.*

A $2,000,000 expansion of *Solar Aircraft's* recently built Wakonda plant in Des Moines has been announced.

The third engineering office of the *Babcock & Wilcox Co.* to be located in Florida within the past two years will be opened in Miami.

Pangborn Corp. has completed a new addition to its production facilities in Hagerstown. The new structure is designated Building No. 8.

Plans for construction by *Monsanto Chemical Co.* of multi-million dollar facilities for the production of isocyanates have been announced.

Federal Electric Products Co. is now completing a new plant in Los Angeles scheduled to start production within the next month.

As the first licensee of the *American Mollerizing Corp.*, Beverly Hills, Calif., *Light Metal Processors, Inc.*, Redwood City, Calif., will construct a new quarter million dollar plant. The firm is headed by Harold G. Erstrom.

Tri-Point Manufacturing and Developing Co., has recently completed and moved into a new and modern plant at 401 Grand St., Brooklyn, N. Y.

Dow Chemical Co. has announced opening of its new *Edgar C. Britton Research Lab.*, named in honor of its *Organic Research Lab.* director.

The heavy press program stepped into high gear as ground was scheduled to be broken for the building to house two massive forging presses. The new building will be located adjacent to *Aluminum Co. of America's* Cleveland Works, where Alcoa maintains large aluminum and magnesium forging facilities.

General Electric Co.'s Welding Dept., located in Fitchburg, Mass., will be

Wobble means wear
Formula for Failure
w
+
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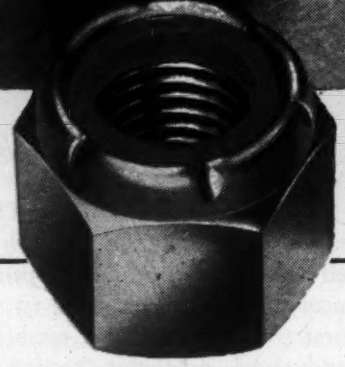
s
+
α
×
v
=
a loose connnection



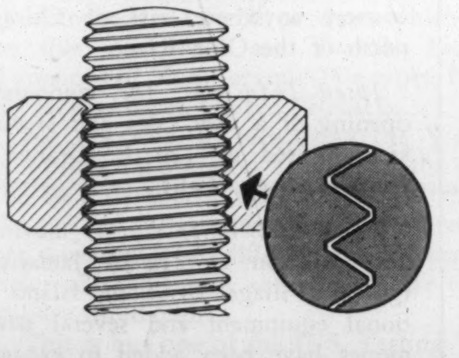
Elastic Stop nuts can't wobble

Formula for Failure—[(w) Initial thread wear + (e) bolt stretch + (s) thermal expansion or contraction + (α) wobble] × (v) vibration = a loose connection.

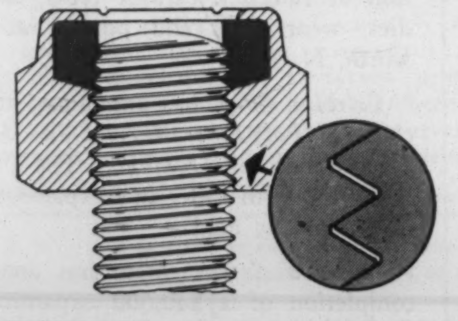
Wobble, permitted by normal axial thread play, and vibration are two of the major elements contributing to thread wear, loose connections and ultimate failure of a threaded fastener.

One device – the elastic locking insert – eliminates axial play and dampens destructive, wear-producing vibration. Because of the locking action of ESNA's famous red elastic collar, ELASTIC STOP nuts *do not loosen under vibration.*

Other important ESNA advantages include quick application and precise adjustment, reuseability, protection against liquid seepage, and uniform bolt loading. Mail our coupon for design information.



YOU CAN WOBBLE AN ORDINARY NUT AND BOLT with your fingers. This is the result of the tolerance spread permitted by the several classes of thread fit.



GRIPPING THE BOLT WITH A PERFECT FIT, ESNA's red elastic collar enforces a constant downward pressure that eliminates axial play, enforcing a positive contact between load-carrying sides of bolt and nut threads.

ELASTIC STOP NUT CORPORATION OF AMERICA

also maker of the ROLLPIN

Elastic Stop Nut Corporation of America
Dept. N36-861, 2330 Vauxhall Road, Union ,N. J.
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name________ Title________

Street________

City________ Zone____ State________

HIGH TENSILE · ANCHOR · HIGH TEMPERATURE · SPLINE · CLINCH · GANG CHANNEL · NYLON CAP

Only ESNA manufactures a complete line of all types and sizes of self-locking nuts

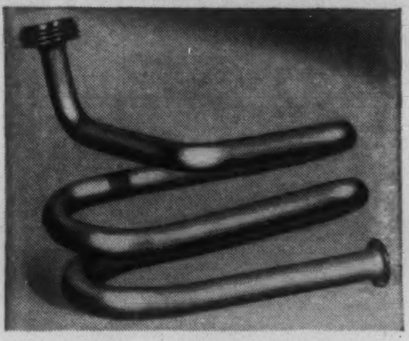
STOP CORROSION LOSSES...

Caused by Sulfuric, Nitric, Phosphoric Acids

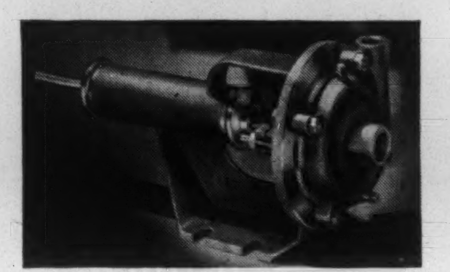
Specify parts made of

ILLIUM

... the corrosion, erosion and heat resistant alloy



Shown above is ILLIUM welded tubing. This small-diameter tubing is easily bent and flared to exact tolerances. It may be welded to itself or other metals, and retains its bright finish in service.



The ILLIUM Utility Pump

A rugged pump designed for laboratory, pilot plant, and small industrial applications. Made entirely of ILLIUM, it will not contaminate material being pumped, and will often outlast stainless steel pumps as much as 5 times. Write for catalog information.

Critical processing operations involving corrosive liquids and gases have proved Illium's ability to slash replacement and maintenance costs down to a minimum.

Unequalled in resistance to attack by all concentrations of sulfuric acid, at virtually all temperatures, Illium is similarly well-suited to handling nitric, phosphoric, and mixed acids, and many acid-salt solutions. Over the years, it has firmly established its superiority over other alloys in the chemical, drug, petroleum, and food industries.

Available in castings up to 575 lbs., Illium is easily machined and welded. Samples for testing and investigation will be sent on request.

Write for Bulletin 651 for complete data.

THE ILLIUM CORPORATION, FREEPORT, ILLINOIS

Makers of Special Alloys and Quality Castings for Industry

MECHANICAL TUBING

PROMPT DELIVERY FROM STOCK

Call Murray's nearest warehouse for seamless cold-drawn mechanical tubing in carbon steel; also for seamless or welded stainless tubing in many analyses; size range . . . 1/8- to 14- inch O. D.

For aid in finding the tubing best suited to your particular need, consult a Murray representative. He may help you uncover new economies in the purchase of mechanical tubing.

WRITE FOR CURRENT STOCK BULLETIN

Other Murray products include carbon steel tubing and pipe for mechanical and pressure purposes; Welding and screw type pipe and tube fittings. Tube bending, upsetting, swaging.

A B MURRAY CO INC
ESTABLISHED 1845
ELIZABETH, N. J. McKEESPORT, PA.

News Digest

News of Companies (cont.) . . .

transferred to York, Penna., by the end of March, 1954.

Laclede-Christy Co. has announced the purchase of the plant properties of *Whitehall Sewer Pipe and Stoneware Co.*

A new factory will be opened shortly at Warren, Ill., to expand the production of the *Micro Div.* of *Minneapolis-Honeywell Regulator Co.*

Hydraulic Press Mfg. Co. has announced a new manufacturing center abroad which will produce the full line of H-P-M equipment for distribution in Western Europe and other territories.

Formation of *Rubarite Inc.*, a company which will manufacture and sell synthetic rubber powders for use in asphalt has been announced by the joint owners, *Goodyear Tire & Rubber Co., National Lead Co.*, and *Berry Asphalt Co.*

A. F. Holden Co. has announced the opening of a plant to serve the West at 3311 E. Slauson Ave., Los Angeles 58.

A completely new aluminum rolling and extrusion mill will be opened in Lincoln Park, Mich. by *Wisco Aluminum Corp.* late next July. This will make the company the seventh in the United States to become a prime mill producer of aluminum, and it will be the first such mill to be established in the industrial northeast section of the country anywhere east of Chicago and north of the Ohio River.

Ipsen Industries, Inc. announced the opening of a new sales and service division located at 120 E. Orange Grove Ave., Burbank, Calif.

Ebert Electronics Co. is moving to a new location at 212-26 Jamaica Ave., Queens Village 28, Long Island. Additional equipment and several new techniques have been added to expand both engineering and production facilities.

Adamas Carbide Corp. is erecting a new million dollar plant for the production of tungsten carbide tools, tool tips, dies, wear parts and powder at Kenilworth, N. J.

Calresin Corp. has announced the purchase of *Poly-Fiber, Inc.* of Los Angeles, a subsidiary of *Dumont*. The purchase is in line with Calresin's expansion plans in the plastic field.

Seaboard Screw Corp. has announced completion of a $40,000 expansion program that will increase plant capacity 90%.

Kawneer Co. has formed a subsidiary with headquarters in Toronto, Ont., under the name of *Kawneer Canada, Ltd.*

Opening of a new, modern rubber roll covering plant for its subsidiary, the *Manhattan Rubber Mfg. Co.*, at Neenah, Wis., has been announced by *Raybestos-*

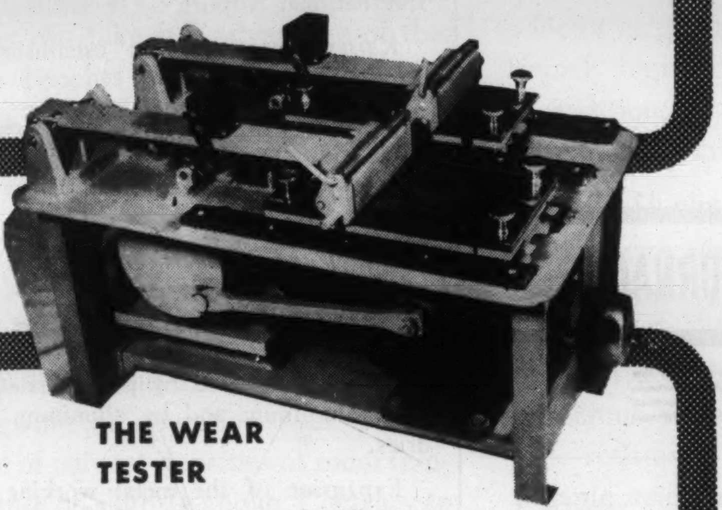
TESTING INSTRUMENTS
you can keep busy
ARE ECONOMICAL
TESTING INSTRUMENTS

In building our Testing Instruments, we always strive for *adaptability to multiple uses,* while maintaining essential reliability, accuracy, sturdiness, and simplicity of operation.

We use these testing instruments ourselves, in our tests and sponsored research for thousands of industrial clients. So we know that equipment which can be kept busy is a good buy, a good investment.

We know that the instrument designed for several purposes, or for testing many different products, is more likely to be busy than the instrument serving one limited use.

One of the busy-because-versatile Testing Instruments which we build and sell is shown:



THE WEAR TESTER

Used in our own Laboratories for evaluating Wear-Resistance of Plastics, Textiles, Leather, Rubber, Alloys, Coatings, and many other materials. Among the hundreds of specific products which can be tested by this instrument are: Pencils, Fish-line, Floor Coverings of Non-Ceramic Tile types, Printed Effects on various bases, Coated Products.

For example, in measuring the Wear-Resistance of a printed pattern on Vinyl Film, the abradant used can be a dampened standard fabric, rubbed against the printed film under a fixed low pressure. Results are repeatable, can differentiate degrees of quality of print adhesion, and actual-use wear conditions are validly simulated.

This is but one of the U. S. Testing Wear Tester's many applications in Control Tests, Comparative Evaluation Tests, and Research Studies. Let us show how this instrument can be adapted to your particular problem of Wear Testing.

The United States Testing Company, Inc. is a service organization for testing, inspection, research, and product development. It serves practically every segment of industry in fields of chemistry, biology, physics, and engineering. A staff of over five hundred persons is always ready to concentrate a maximum of professional skill upon each project.

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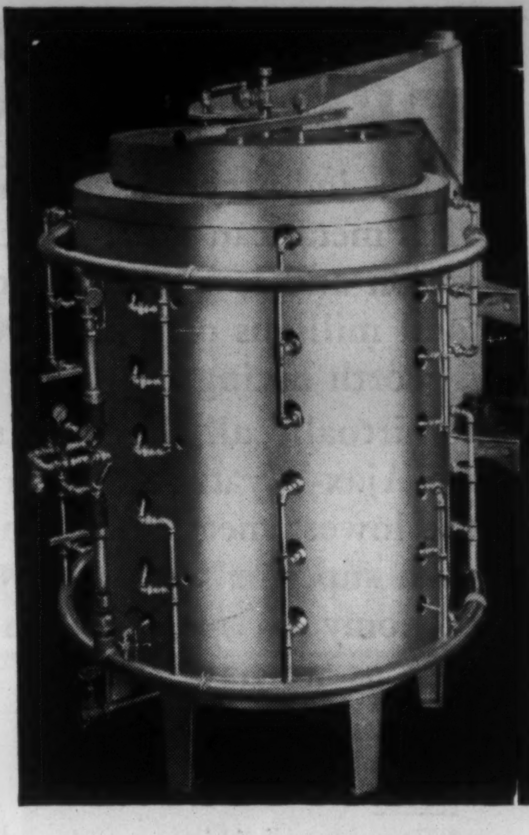
Toronto W. J. WESTAWAY COMPANY, Ltd. Winnipeg

CLEAN CARBURIZING

of -
BALLS,
CUPS,
SHAFTS,
GEARS,
RINGS,
CONES

etc. with this

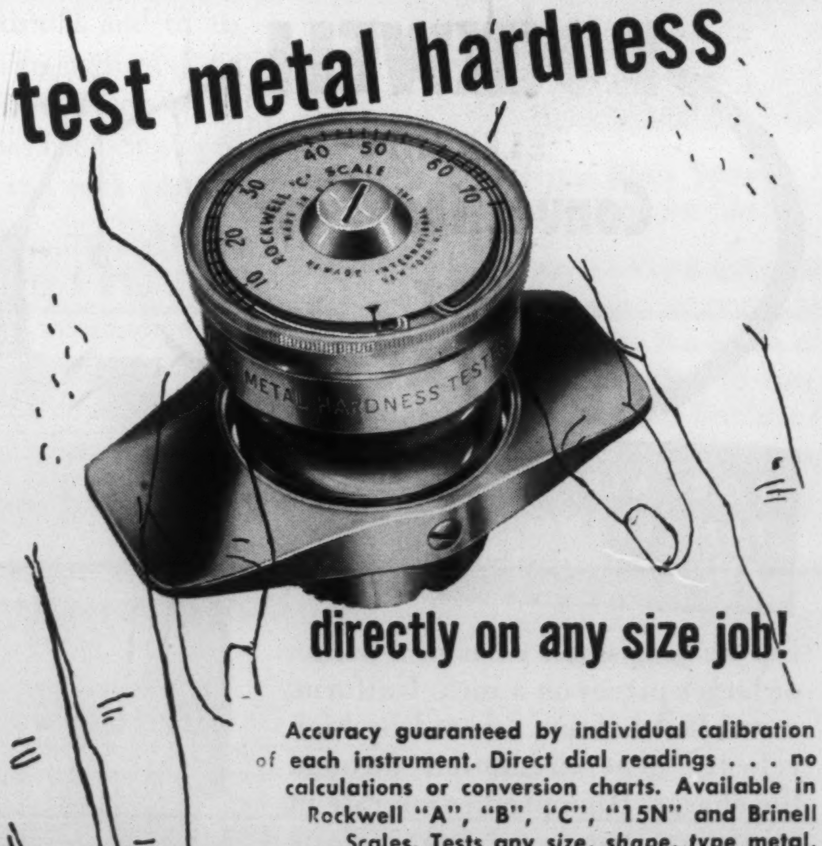


AGF MODEL NO. 19C VERTICAL CARBURIZER. Developed by the PIONEERS, this well-built long life furnace may be used for "Ni-Carbing" and many other controlled atmosphere purposes. Ask for Bulletin No. 1214

AMERICAN GAS PIONEERS 1878 FURNACE CO.

AMERICAN GAS FURNACE CO.
1008 LAFAYETTE STREET, ELIZABETH 4, N. J.

test metal hardness



directly on any size job!

Accuracy guaranteed by individual calibration of each instrument. Direct dial readings . . . no calculations or conversion charts. Available in Rockwell "A", "B", "C", "15N" and Brinell Scales. Tests any size, *shape, type* metal, on-the-job!

WRITE FOR BOOKLET ET 440
OR DEMONSTRATION
TERRITORIES OPEN!
DISTRIBUTORS INQUIRE!

ERNST
portable metal hardness testers
Manufactured in the United States

NEWAGE INTERNATIONAL, INC.
235 EAST 42nd STREET, NEW YORK 17, N. Y.
IN CANADA: NEWAGE (CANADA) LIMITED, 1174 BAY STREET, TORONTO, ONTARIO

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

** Upwards of 5 billion pounds annually.*

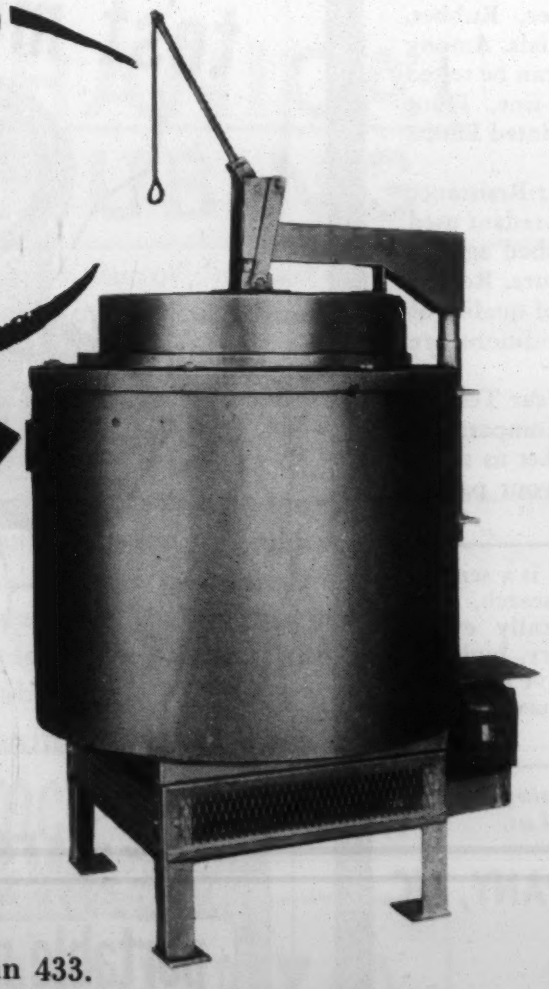
AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

ROCKWELL
ELECTRIC
Convection Type
PIT
FURNACES

FOR AIR DRAWING
TEMPERING • AGING
ANNEALING TO 1250°F.



For heating small parts in a basket or larger pieces on a rack. Uniform, controlled heating assured by high velocity heat circulation through the charge. High production rate in minimum time and space. Four standard sizes with charge capacity of 0.55 – 2.3 – 14.4 and 68.7 cu. ft. Other sizes and gas-fired units built to requirements.

Write for Bulletin 433.

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ROCKWELL BUILT SINCE 1888
FURNACES • OVENS • BURNERS • VALVES • SPECIAL MACHINERY
2083 ELIOT STREET • FAIRFIELD, CONN.

News Digest

News of Companies (cont.) . . .

Manhattan, Inc. The plant expands existing facilities for rubber covering rolls for the paper and other industries in the Midwest.

Bjorksten Research Labs., Inc. has announced that its Chicago office and laboratories will be moved to 1525 E. 53rd St., Chicago 15.

Bryant Machinery & Engineering Co. has announced the removal of its general offices to 640 W. Washington Blvd., Chicago 6.

Ground has been broken by the *Plexolite Corp.* for its new manufacturing plant to be located on Maple Ave. in El Segundo, adjacent to the Los Angeles International Airport.

Kaiser Engineers has established an *Atomic Energy Div.*

Peter A. Frasse and Co., Inc., recently held opening ceremonies at its new office and warehouse building in Tonawanda, N. Y.

Alloys and Products, Inc. has embarked on a program of the volume production of titanium-aluminum alloys. The principal products will be the 5% titanium alloy which is used by producers of primary aluminum and by aluminum foundries.

Expansion of the metal working division of *DeVilbiss Co.* has been announced. To handle the company's expanding business, an addition is being built onto the present building occupied by the sheet metal div.

Dearborn Chemical Co. has announced the removal of its *Eastern Div.* to 1601 Linden Ave., E., Linden, N. J.

Alpha Tool & Supply Co. has moved to Closter, N. J. At the new location, larger facilities will permit expansion.

Cornell-Dubilier Electric Corp.'s giant new capacitor manufacturing plant, being built at Sanford, N. C., is nearing completion. The new plant is expected to provide 270,000 sq ft of operating space.

A ground breaking ceremony was recently held by *Eutectic Welding Alloys Corp.* for its new No. 3 plant to be built on land adjoining Plant No. 1.

N. Ransohoff, Inc. recently moved from its original location in Elmwood, Ohio, to a much larger and completely modern plant in Hamilton, Ohio. The move provides the company many advantages in greatly enlarged production facilities, and the consolidation of all administrative, engineering, experimental, and sales departments in one location.

Kold-Hold Mfg. Co. has announced a change in its corporate name to *Tranter Mfg. Co.*

Sprague Electric Co. is currently undertaking construction of a new plant in the Blue Ridge Mountain area in extreme

In Tin Plating

Increase Your Output . . .

Cut Costs . . . Get Better Results

use B&A TIN FLUOBORATE SOLUTION

Restrictions are off tin! Once again platers can take full advantage of the many benefits obtained through the use of Baker & Adamson's Tin Fluoborate Solution. Those who have already used it know that this versatile plating solution offers an unusual combination of advantages not available in other tin baths.

For example, the Tin Fluoborate bath is capable of operation over a wide range of current densities at room temperature or slightly above. Contrary to the general rule this *acid bath* has good throwing power, and because both anode and cathode efficiencies are about 100%, the bath is practically self-sustaining, only an occasional check of pH and specific gravity being required for control. The high stability of B&A Tin Fluoborate makes possible the formulation and use of baths with a very high metal content, a factor of great importance where extremely high plating rates are desired. In addition, deposits are fine grained, smooth and white in color.

B&A Tin Fluoborate is finding use for plating wire, electrotype shells and on parts where ease of soldering is required. In addition, it is also being used on a large commercial scale for numerous fabricated articles to provide resistance to corrosion attack by organic acids in foodstuffs and to atmospheric tarnish. The bath may be used to deposit tin directly on brass, copper or steel and has been employed in both barrel and still tank plating.

For detailed bulletins on Tin and Lead-Tin Plating from the B&A Fluoborate bath, or for further information on other B&A Fluoborate Plating Chemicals, simply fill out the coupon below, attach to your company letterhead and drop it in the mail.

B&A Tin Fluoborate Bath Speeds Preparation of Electrotype Shells

B&A Tin Fluoborate is finding growing acceptance among electrotypers for plating a thin deposit on the backs of electrotype shells preparatory to casting. Here it replaces the old-fashioned hand foiling operation and does a better job at less cost.

REAGENTS
B&A
STANDARD OF PURITY
FINE CHEMICALS

Fluoborate Plating Chemicals—

Lead	**Cadmium**
Tin	**Indium**
Iron	**Antimony***
Copper	**Chromium***
Nickel	**Cobalt***

Fluoboric Acid

*Experimental quantities only.

SEND COUPON
today for further information.

BAKER & ADAMSON PRODUCTS
GENERAL CHEMICAL DIVISION,
Allied Chemical & Dye Corporation
40 Rector Street, New York 6, N. Y.

Please send me bulletins checked below:
- ☐ Tin Plating from the Fluoborate Bath (No. 749)
- ☐ Tin Plating of Electrotype Shells (No. 949)
- ☐ Lead Tin Alloy Plating from the Fluoborate Bath (No. 152)
- ☐ Lead Tin Alloy Plating in Electrotyping and other Applications (No. TS-LTE-152)
- ☐ Metal Fluoborate Solutions (outlines important applications of the various B&A Fluoborate Baths)

Name ....

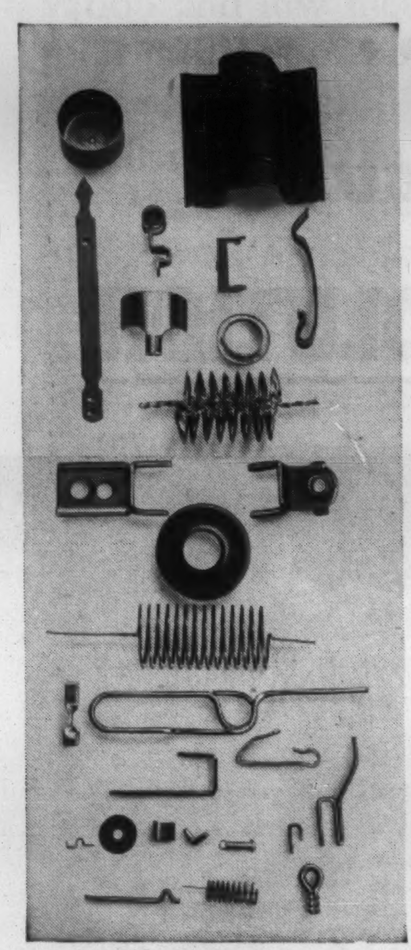
Organization .... Position ....

Address ....

City .... Zone ...... State ....

Major kinds of plating done ....

.... MM-8



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WIRE FORMS

& Metal Stampings

High-speed, quality production with custom-made precision. Wire formed to any shape for every need.

IMMEDIATE CAPACITY FOR DEFENSE SUB-CONTRACTS

STRAIGHTENING & CUTTING

Perfect straight lengths to 12 ft.
.0015 to .125 diameter

WIRE FORMS

.0015 to .125 diameter

SMALL METAL STAMPINGS

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.062 to 3 inches wide

Specializing in Production of Parts for Electronic, Cathode Ray Tubes & Transistors

Write for illustrated folder.
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ART WIRE and STAMPING COMPANY

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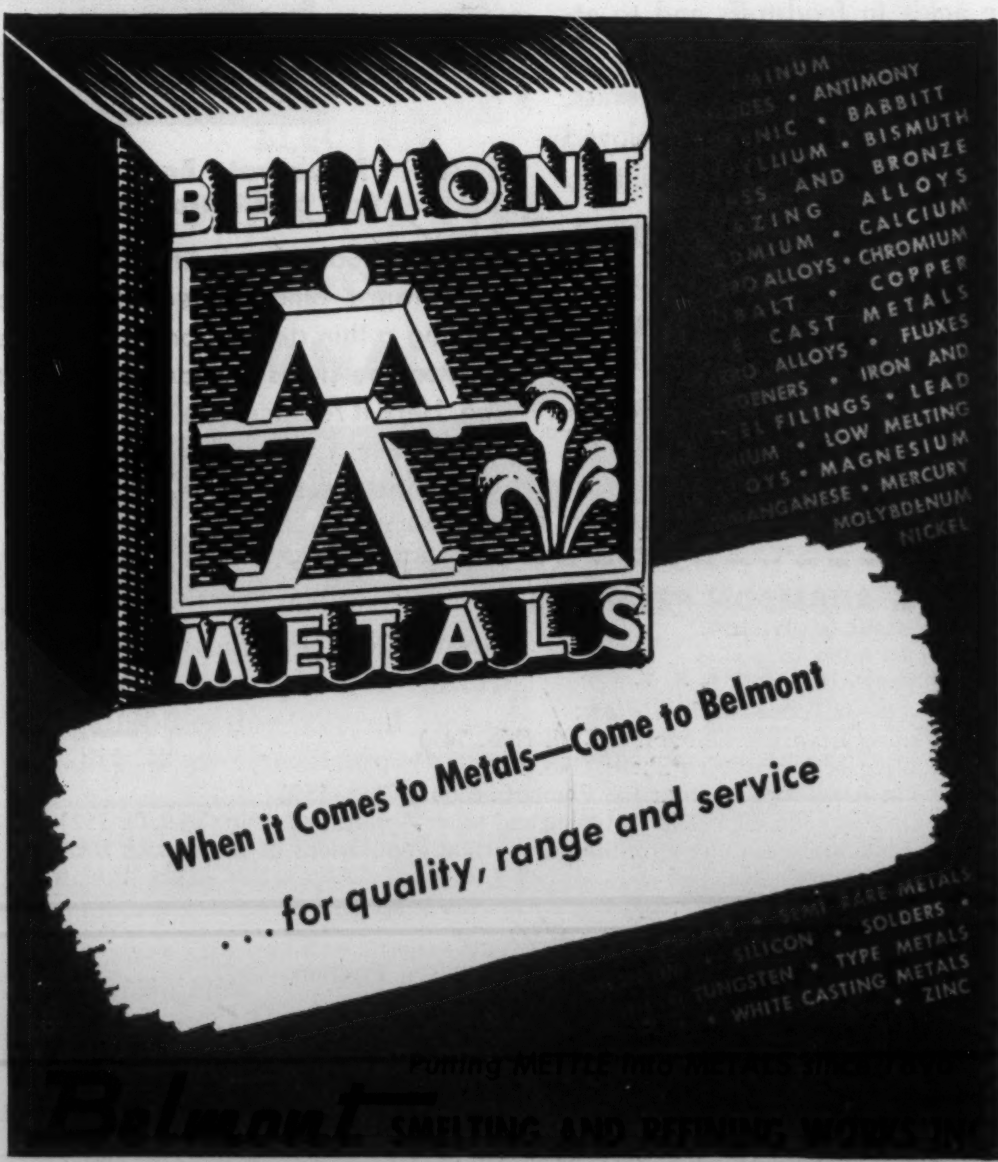
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...ALT • COPPER
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...EL FILINGS • LEAD
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ALL METALS • ALL ALLOYS • ALL FORMS

News Digest

News of Companies (cont.) . . .

northwestern North Carolina. The plant is expected to employ about 250 workers and will manufacture capacitors.

Andrews-Alderfer Co. has announced the establishment of a new plant and home office at 1055 Home Ave. in Akron to meet the increasing demand for foam-coated fabrics.

A functional 2-story laboratory and headquarters structure, planned to provide maximum area for research work as well as space for future expansion, is planned for construction by *Midwest Research Institute* in Kansas City. Construction is expected to get underway in the fall.

Establishment of a *Direct-Current Motor and Generator Dept.* by the *General Electric Co.* has been announced. The new department will be located in Erie, Penna.

Westinghouse Electric Corp. has broken ground for a new modern Research Center to be located 10 miles east of downtown Pittsburgh's Golden Triangle. The new facilities are expected to be completed early in 1955.

A comparison seminar on organic bonding is scheduled for the early fall by *Eutectic Welding Alloys Corp.* at its training institute in Flushing, N. Y. It will continue for four days and is open to all who wish to investigate adhesive bonding of materials.

Metlab Co. recently celebrated its 25th Anniversary. Nearly 400 representatives of industrial firms attended an Open House party at the company plant.

A new clad metal plant which will produce gilding metal-clad steel strip for bullet jackets is now ready for full scale operation by *Superior Steel Corp.* The plant will increase the company's clad metal capacity from 30,000 tons to approximately 80,000 tons per year. Built and equipped jointly by Superior and the *Ordnance Corps* at a cost of $7,750,000, the plant will operate under new methods and processes which are expected to save the government between $100 and $150 a ton.

McAleer Mfg. Co. has changed its corporate name to the *Goodison Mfg. Co., Inc.*

Open House ceremonies were recently held at the new mill-branch warehouse and office of *The Carpenter Steel Co.* at Belmont, Calif.

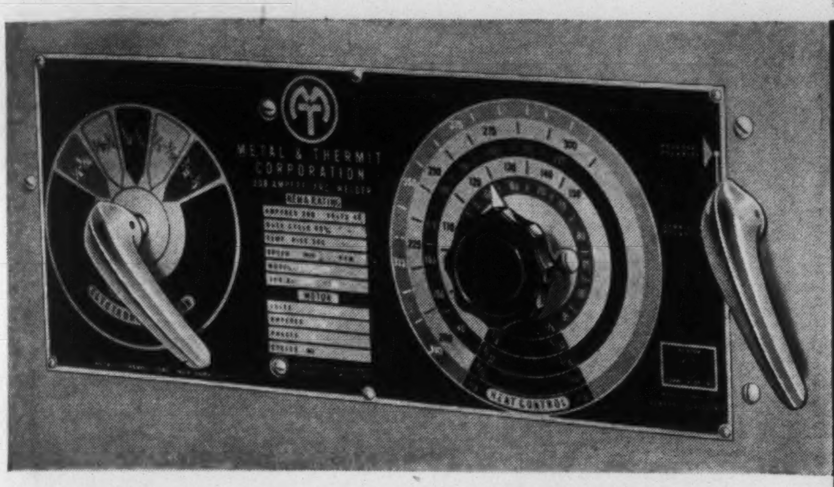
Enthone, Inc. announced the completion of increased manufacturing and warehousing facilities at its plant. The added area amounts to 6600 sq ft.

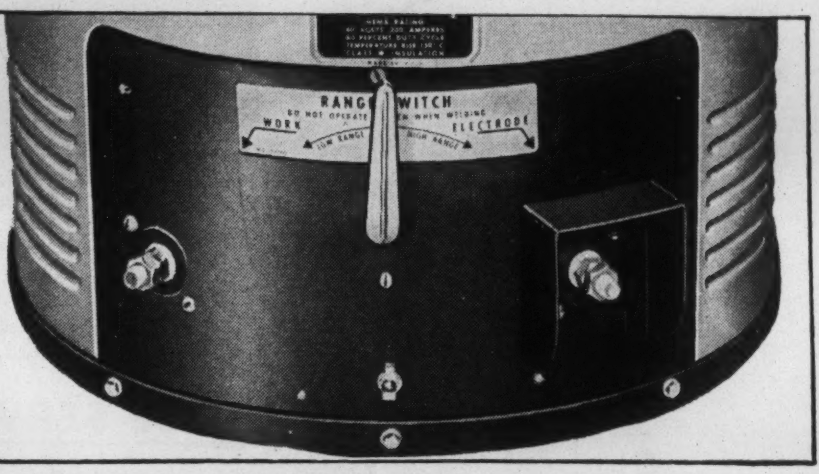
Acquisition of *American Lava Corp.* by *Minnesota Mining & Mfg. Co.* through a $5,000,000 stock transfer has been announced. All officers of American Lava will continue in their present capacities.

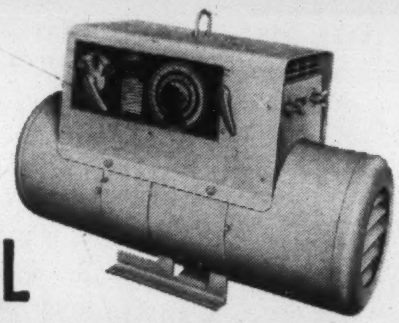
Stillman Rubber Co. and John F. Drescher have joined forces to form *Microloc,*

NEW CONTROL SYSTEMS on M & T WELDERS for

GREATER ACCURACY and CONVENIENCE

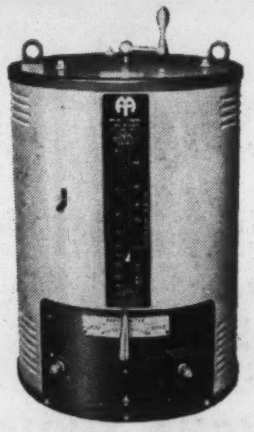






ONE-DIAL DOUBLE CONTROL PANEL *eliminates plug-ins on* DC WELDERS

New control system on all M&T DC Machines now makes regulation of welding current easy and positive! Simply set the electrode selector, then dial for required current . . . Welders are available in light-duty 200 amp and heavy-duty 200, 300 and 400 amp models — motor-generator or gas-driven.



RANGE SWITCH to SPEED RANGE CHANGING ON AC WELDERS

New range switch provides rapid changing from high to low or low to high range . . . No cable leads to unplug, no connections to make . . . Case mounted primary switch permits turning off welder to save current between welds . . . M & T AC Transformers, all silicone insulated, are furnished in light-duty 200 amp and heavy-duty, industrial ratings of 200, 300 and 400 amp.

Investigate these *improved* DC and AC Machines as well as M & T INERT ARC WELDERS and RECTIFIERS. They're all part of a *complete* line — second to none!

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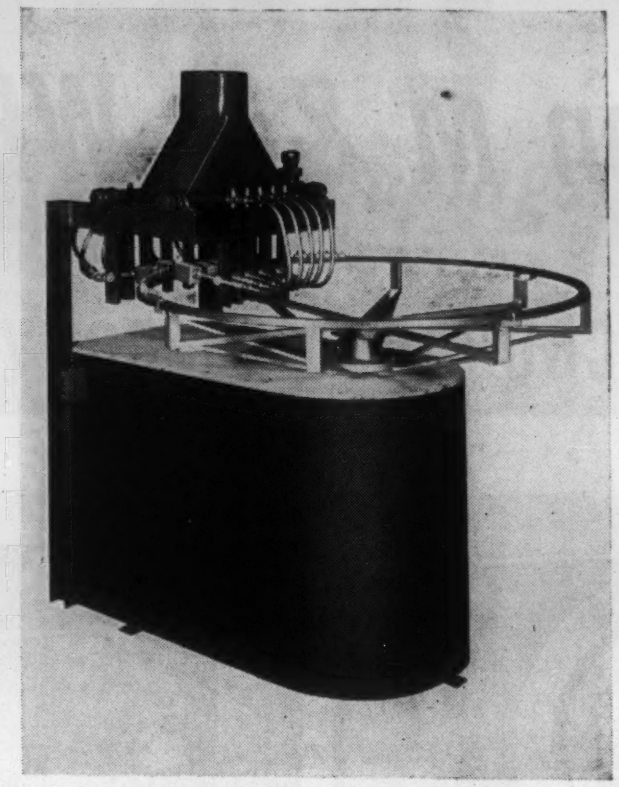
(up to 3000 units per hour)

G. A. S.
(Gas-Fired)
HIGH SPEED
HEATING UNITS

- Use city gas and air—equipped with high speed burners.
- Handle large variety of sizes and shapes. Available with stationary or rotating holding fixtures.
- Production rates as high as 3,000 pieces per hour.
- Now being extensively used for brazing bomb and shell assemblies, annealing cartridge cases, etc.
- For further details on G.A.S. Turntable and Conveyor-Type Heating Units, write for Bulletin No. 511.



G.A.S. Standard Turntable Heating Unit with variable speed drive

GAS APPLIANCE SERVICE, INC.
Industrial Gas Engineers
1213 WEBSTER AVENUE • CHICAGO 14, ILLINOIS

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News Digest

News of Companies (cont.) . . .

a new venture for research, design and development of electromechanical specialties and armament equipment for use in aircraft and guided missiles.

Copper Precision Products will become a wholly-owned subsidiary of *Standard Pressed Steel Co.*

Hobart Brothers Co.'s new $3,000,000 electrode plant in Troy, Ohio is now in full production.

Howard Foundry Co. recently took over management of the *Alumicast Corp.* The name Alumicast Corp. will be retained but the company will be operated through Howard's general offices at 1700 N. Kostner Ave., Chicago.

General Electric Co. has established a new unit called the *Advance and Development Engineering Unit.* Headed by Earl F. Arnett, former supervisor of manufacturing engineering, the organization will devote full attention to the development of future manufacturing processes and new products in the company's line of G-E Textolite decorative laminates, industrial laminates and insulating materials.

Meyer Engineering Co. has moved its offices and plant to 19229 Mt. Elliott Ave., Detroit 34.

In a move to expand its operating facilities, *Aeroquip Corp.* has acquired the plant of *Sterling Electric Motors,* Inc. in Van Wert, Ohio.

Worthington Corp. has announced plans for an expansion and modernization program at its Plainfield Works.

General Ceramics and Steatite Corp. has announced formation of a new Applications Engineering Dept.

The *Ferro Corp.* has announced that it will manufacture and sell a new frit especially developed by *The DuPont Co.* for the coating of aluminum.

Official opening was recently held of the new 72,000 sq ft *Link-Belt* engineering plant for the design and manufacture of conveying and processing equipment. The new Scarboro, Ont., plant is the second company plant to open within a year and becomes the company's 18th plant.

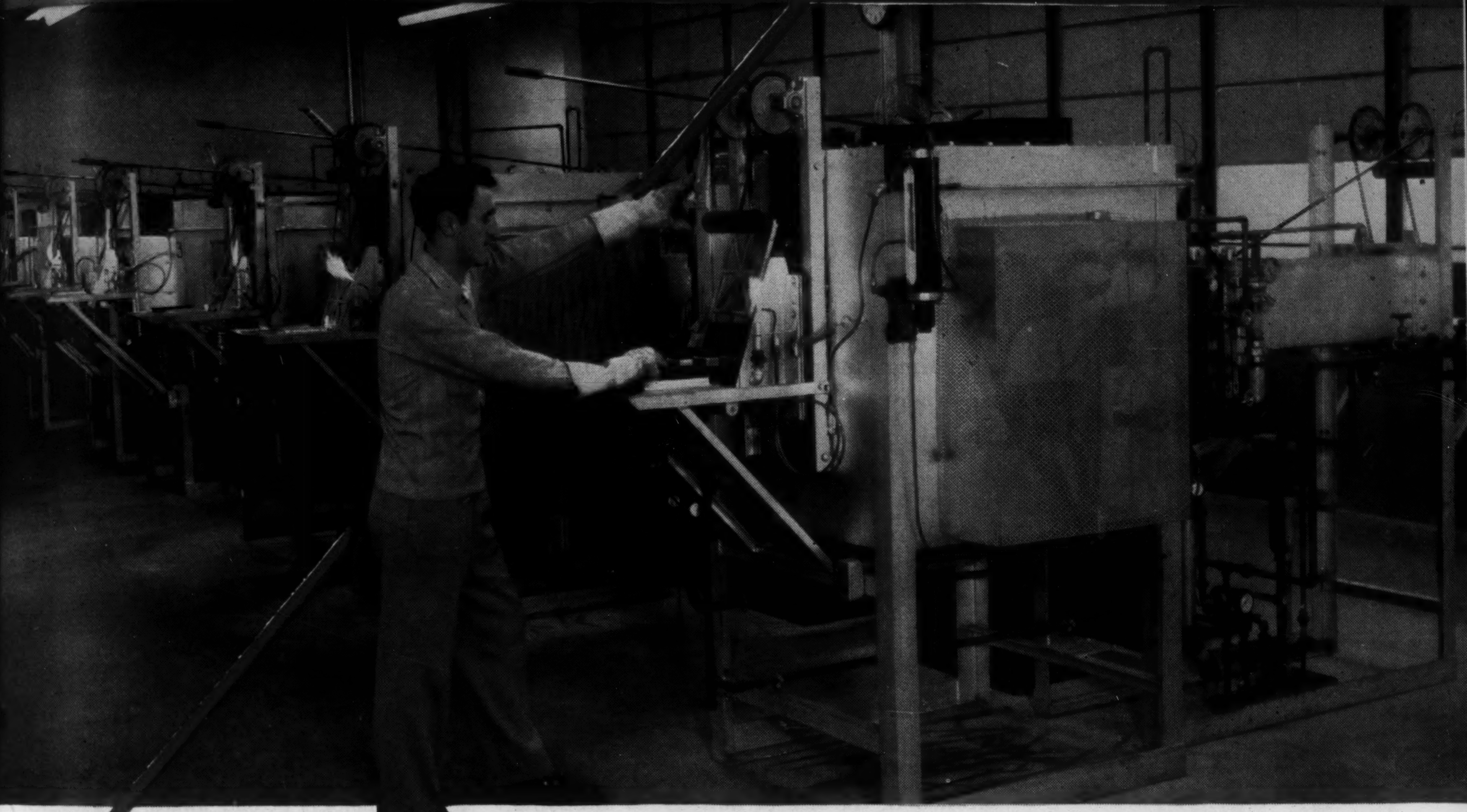
Details of a $750,000 expansion program to increase manufacturing and warehousing space at the *Glidden Co.'s Nubian Industrial Div.* in Chicago have been announced. The facilities to be added mark the fourth major increase to Nubian plants and laboratories since 1946.

Regal Plastic Co. has moved its entire operation to a new location at 14th and Chestnut, Kansas City, Mo.

Goodrich Welding Equipment Corp. is moving its entire operation from Reed City, Mich., to Hudsonville, Mich., where a new factory is now being completed.

Sylvania's Electronics Division employs Hayes Furnaces for critical processes

Magnificent new Sylvania plant at Woburn, Mass.



Utmost cleanliness and precision of operation characterize this Hayes installation at Sylvania, Woburn.

In Sylvania plants from Massachusetts to California, Hayes controlled-atmosphere furnaces yield top quality work on a volume production basis in such critical operations as
—radar microwave TR and ATR tubes: soldering and degassifying.
—magnetron tube sub-assemblies: soldering and degassifying.
—germanium: processing GeO_2 to reduce to purified germanium.
—klystron and rocket tubes, pencil tubes: soldering and degassifying.

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News Digest

News of Companies (cont.) . . .

The country's first industrial laboratory to be devoted exclusively to research and development work on titanium has been formally opened in Niles, Ohio by *Mallory-Sharon Titanium Corp.* The new laboratory will be devoted to basic research, development of titanium and titanium alloys, and production testing.

Alloy Rods Co. has announced that construction has started on its new plant located in El Segundo, Calif. The new plant will produce a complete line of alloy arc welding electrodes to serve the entire Pacific Coast and Rocky Mountain States. It is expected to be in full operation by Oct. 1 of this year.

News of Societies

Six engineering students will receive cash awards as winners in the 1952-53 *Heli-Coil* Engineering Student Design Award Program. Awards were made as follows: First award of $1000 will go to James D. Dunfee of Drexel Institute of Technology. Second award of $500 was won by Joseph F. Klipp, a student at New York University's College of Engineering. Because of a tie, duplicate third awards of $250 will be paid to both Warren C. Bross of the Newark College of Engineering and Robert W. Bradspies, a student at N. Y. U. In addition, two students will receive merit awards of $100. They are Midshipman Ronald E. Adler, 1/c, of the U. S. Naval Academy, and R. J. Murphy of Stevens Institute of Technology.

Bone Engineering Corp. has announced the purchase of *Centrifugal Investment Casting Co.*

Automatic Methods, Inc. has recently completed arrangements for moving all of its operations to Elizabeth, N. J. The new plant will combine all operations of three plants operating in Newark into one larger plant.

The following officers were recently elected by the *American Society for Testing Materials* for 1953-1954: Leslie C. Beard, Jr., assistant director, Socony-Vacuum Labs., Socony-Vacuum Oil Co., Inc., president; Claire H. Fellows, director, Engineering, Lab, and Research Dept., The

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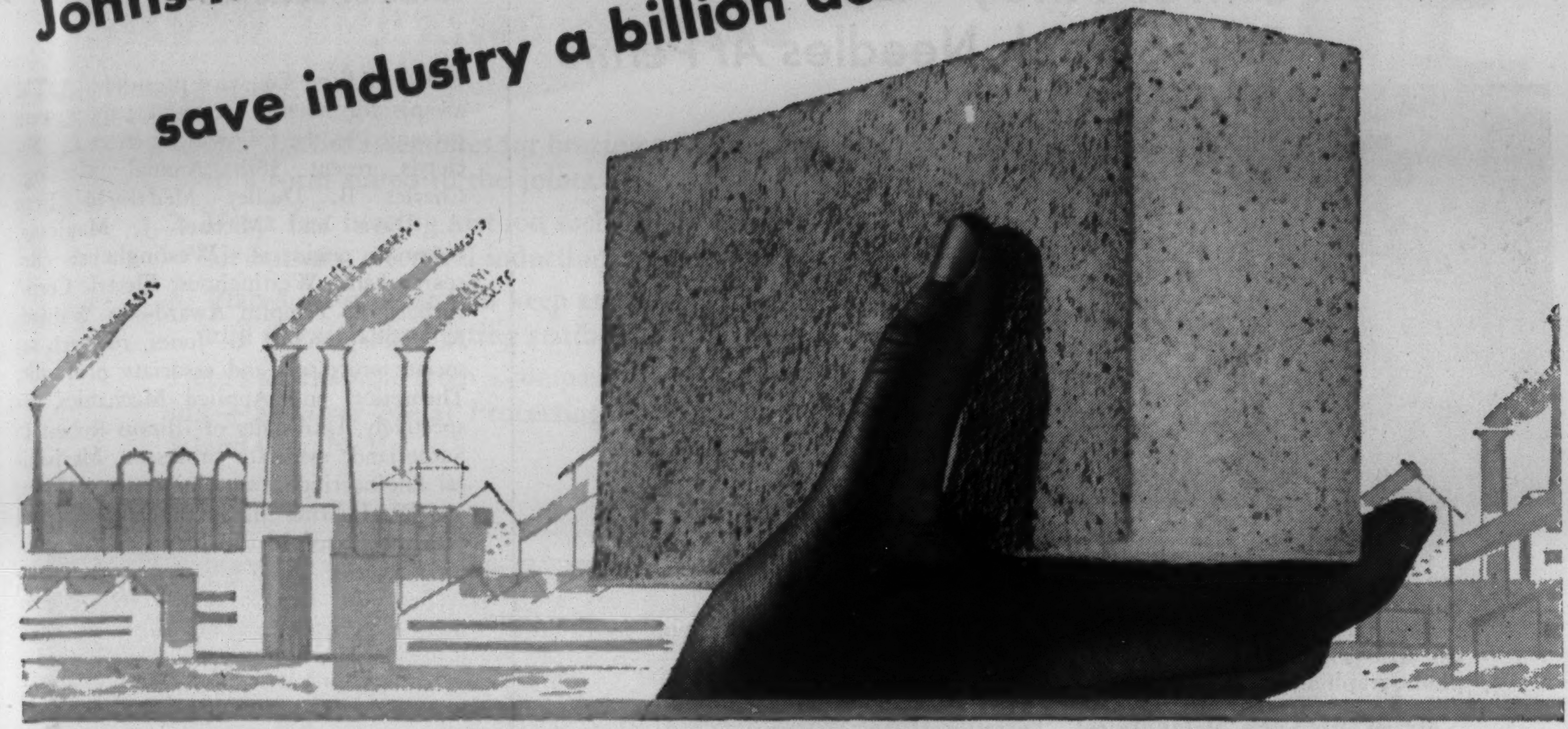

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Johns-Manville refractories meet every need for castable, troweling and gunning applications for temperatures through 3000F. *Firecrete** is used to cast special shapes of all kinds. It is ready for use within 24 hours, has negligible shrinkage and high resistance to spalling. *Blazecrete** is used to build and repair furnace linings. When gunned, it adheres readily with a minimum of rebound loss. When slap-troweled, it eliminates laborious ramming and tamping.

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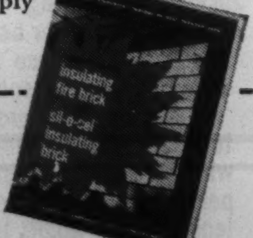

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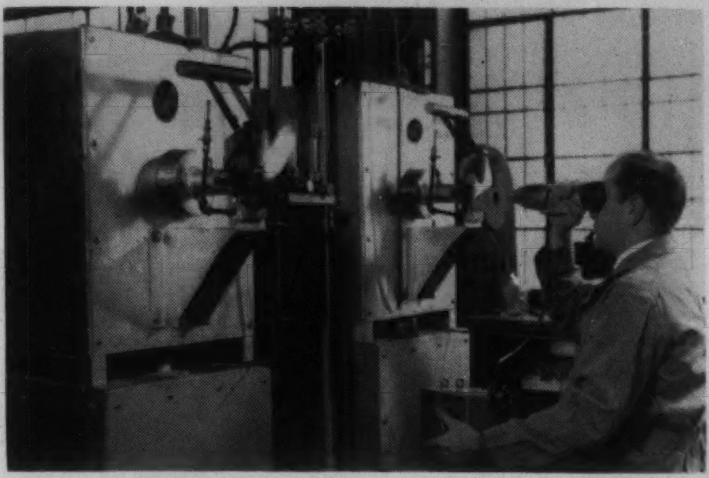

Harper GT-20-HM-30 Tubular Element Furnaces in operation at Permo, Inc. Chicago, Illinois. Max. Temp. 3000°F.
(Photo courtesy of Permo)

The two furnaces shown above are being used extensively for both research and production sintering of various precious metal tip alloys for Permo long-life phonograph needles.

Mr. W. H. Lenz, Metallurgical Director at Permo says: "We have found them very useful, adaptable and economical for this high temperature work. The furnaces are versatile to the extent that they may be operated, if desired, with almost any kind of atmosphere including air."

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News Digest

News of Societies (cont.) . . .

Detroit Edison Co., vice president. ASTM awards for notable technical papers were presented to the following men at the Society's recent 56th Annual Meeting: Charles B. Dudley Medal—to Evan A. Davis and Michael J. Manjoine, research engineers, Westinghouse Research Labs., Westinghouse Electric Corp.; Richard L. Templin Award—to William N. Findley and P. G. Jones, research associate professor, and associate professor, Theoretical and Applied Mechanics, respectively, University of Illinois Robert L. Sutherland, associate professor, Mechanical Engineering, State University of Iowa, and W. I. Mitchell, South Dakota School of Mines; Sanford E. Thompson Award—to Katharine Mather, chief, petrography section, Concrete Research Div., Waterways Experiment Station, Corps of Engineers, Jackson, Miss.; Sam Tour Award—to J. R. McDowell, research engineer, Mechanics Dept., Westinghouse Research Labs., Westinghouse Electric Corp.

New officers of the *Gas Appliance Manufacturers Assn.* were recently elected at the group's 18th Annual Meeting held in White Sulphur Springs, W. Va. Sheldon Coleman, president of Coleman Co., Inc., succeeds James F. Donnelly, vice president in charge of sales, Servel, Inc., as president. Other officers elected were: T. T. Arden, executive vice president, Grayson Controls Div, Robertshaw-Fulton Controls Co., first vice president; W. F. Rockwell, Jr., president, Rockwell Mfg. Co., second vice president; and Lyle C. Harvey, president and general manager of Affiliated Gas Equipment, Inc., reelected treasurer.

Raymond G. Sault, president, Porter Forge & Furnace, Inc., was elected president of the *Drop Forging Assn.* at its 18th Annual Meeting. K. E. Walter, president, Alliance Drop Forging Co., was elected vice president.

New additions to the *Engineering Div., Midwest Research Institute,* include: Irene C. Reese, research electrical engineer; Gerald B. White, Robert Ritter, Gilbert W. Gaarder, and Dale W. Brees, mechanical research engineers.

The following awards were recently made by the *American Electroplaters' Society* in their Philadelphia convention: A. E. S. Silver Medal—to R. F. Ledford, Industrial Filter & Pump Mfg. Co., and E. A. Dominik, Lake Shore Electrotype Co. for their paper, "Comparative Wear Characteristics of Some Electrodeposited Metals"; A. E. S. Bronze Metal—to Stanley L. Eisler of Rock Island Arsenal for "Radioactive Isotope Dilution Method for Determining Sulfate Concentration in Chromium Plating Baths"; Chromium Plating Award—to Lloyd Gilbert, Rock Island Arsenal, W. S. Morrison and Floyd H. Kahler of Illinois Water Treatment Co., for their paper, "Use of Ion Exchange

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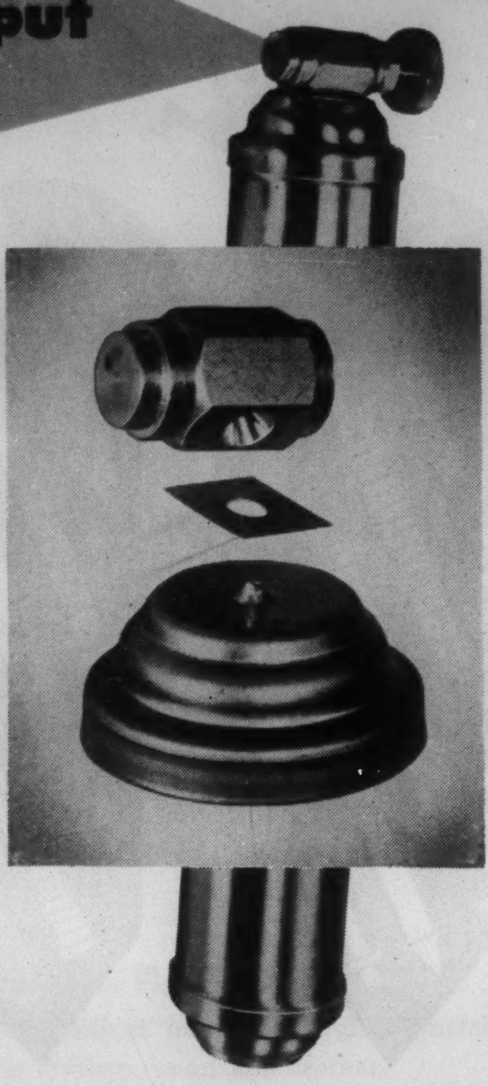

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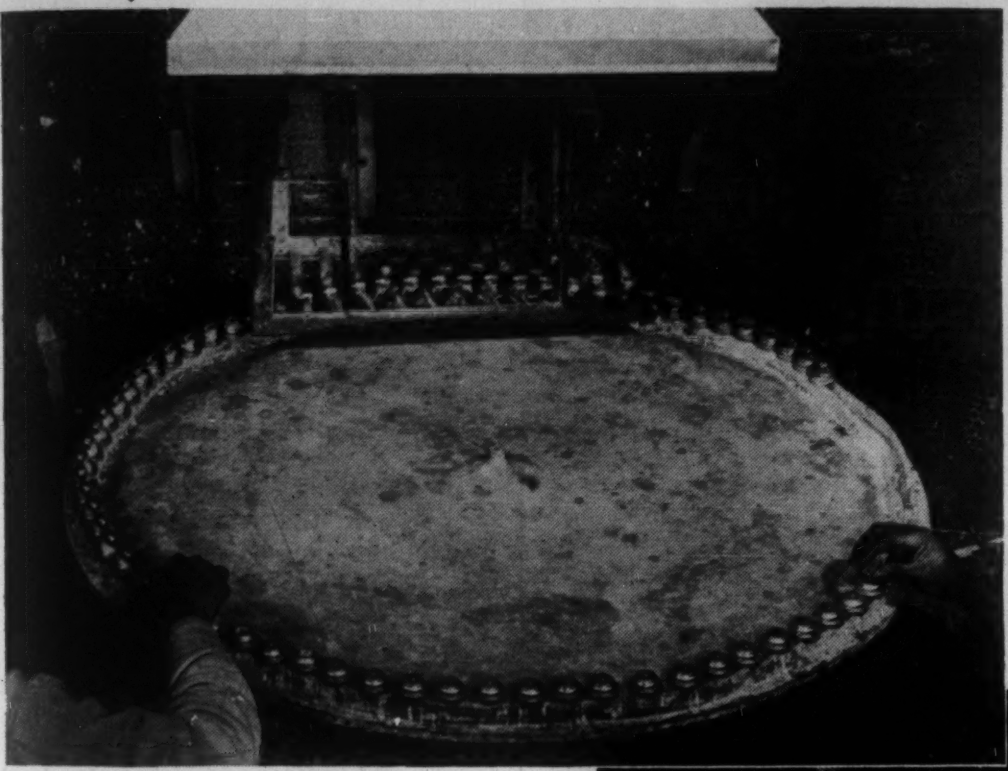
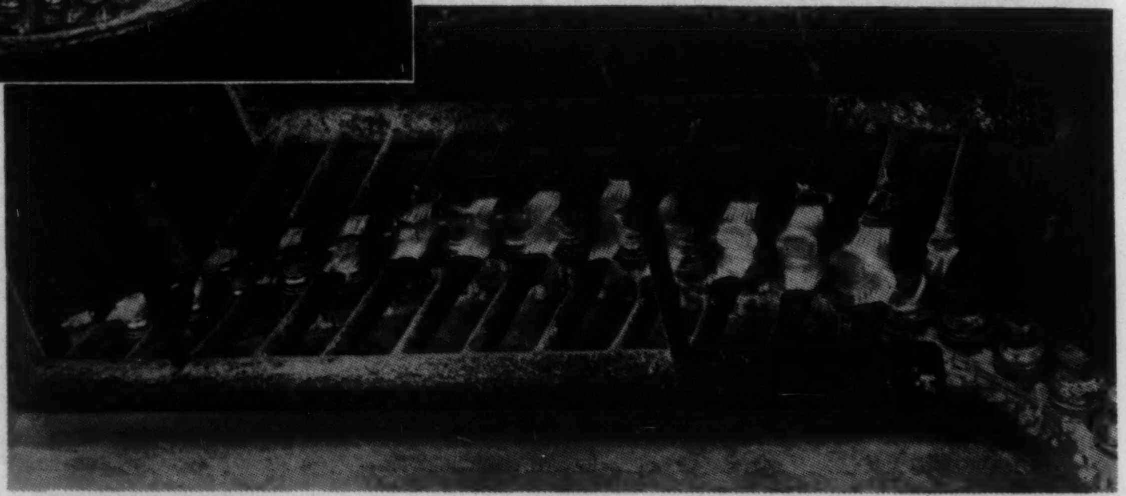
3. Plan a set-up that will keep assemblies moving steadily to and through the heating station.

Here's an example from a company specializing in metal joining — Salkover Metal Processing of New York, Inc., Long Island City, N. Y.

Above are the parts — a brass valve and the cap of a fire extinguisher body, with the 9/16" square of .005" EASY-FLO 35 used to join them. At left is the turntable and gas-air burner set-up, with close-up of burner station below.



Operator at right puts caps on turntable and alloy squares on caps. He also flips finished assemblies into water barrel. Operator at left applies Handy Flux and sets valves on top of alloy. Output — 720 per hour — or one every 5 seconds — and every one strong and permanently leak-tight.



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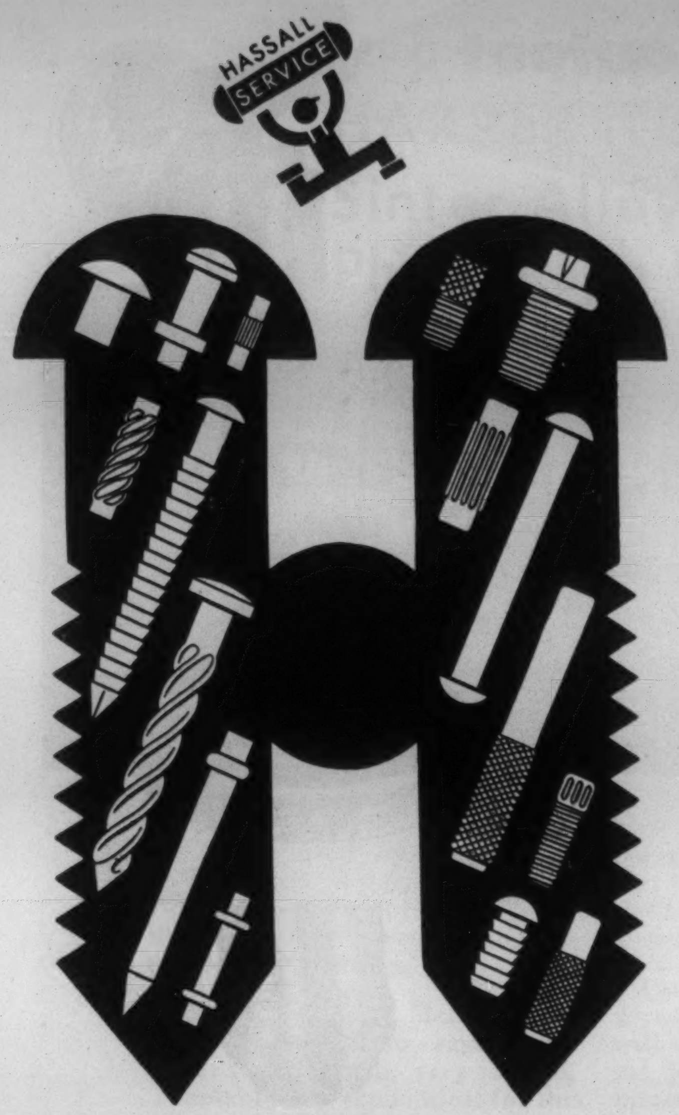

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News Digest

News of Societies Cont. . . .

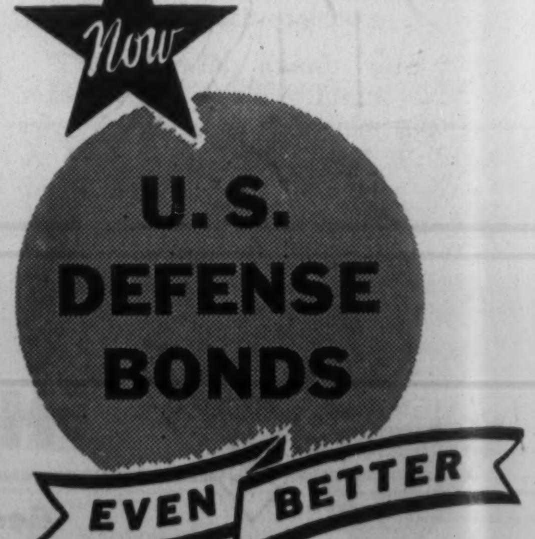
Resins in Purification of Chromic Acid Solutions"; The Precious Metal Plating Award—to Harold J. Wiesner, Bendix Aviation Corp., for his paper, "Some Experiences in Heavy Rhodium Plating".

R. R. Dreibus, vice president in charge of sales and operations, Harvill Corp., has been elected chairman of the *American Die Casting Institute,* Pacific Coast Group.

Max D. Howell was elected executive vice president of *American Iron and Steel Institute* at the annual meeting of the board of directors. B. F. Fairless, chairman, U. S. Steel Corp., and Ben Morrell, chairman, Jones and Laughlin Steel Corp., were elected vice presidents; George S. Rose was reelected secretary; C. M. Parker was elected assistant vice president, and E. O. Sommer, Jr., was elected treasurer. John W. W. Sullivan has been appointed metallurgical engineer of the Institute, succeeding Charles M. Parker.

Richard C. Diehl, president, Chase Brass & Copper Co., was elected president of the *Copper & Brass Research Assn.* at the 31st Annual Meeting held recently. The following vice presidents were also elected: J. A. Doucett, A. R. Zender, M. F. Meissner, E. S. Strang, F. W. Sullivan, W. W. Sieg, and F. R. Slagle. A. G. Wentworth was elected treasurer.

Officers installed at the 55th Annual Meeting of the *American Ceramic Society* recently held in New York City were: R. R. Danielson, manager of Ceramic Service, Metal & Thermit Corp., president; R. W. Pafford, president elect; Stephen M. Swain, Joseph A. Pask, J. Eugene Eagle, vice presidents; and Robert Twells, treasurer.



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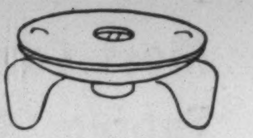

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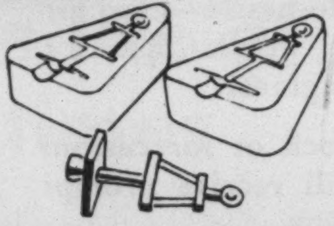

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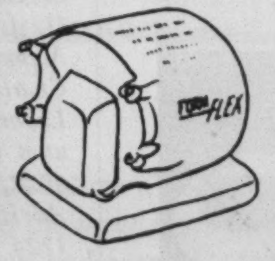

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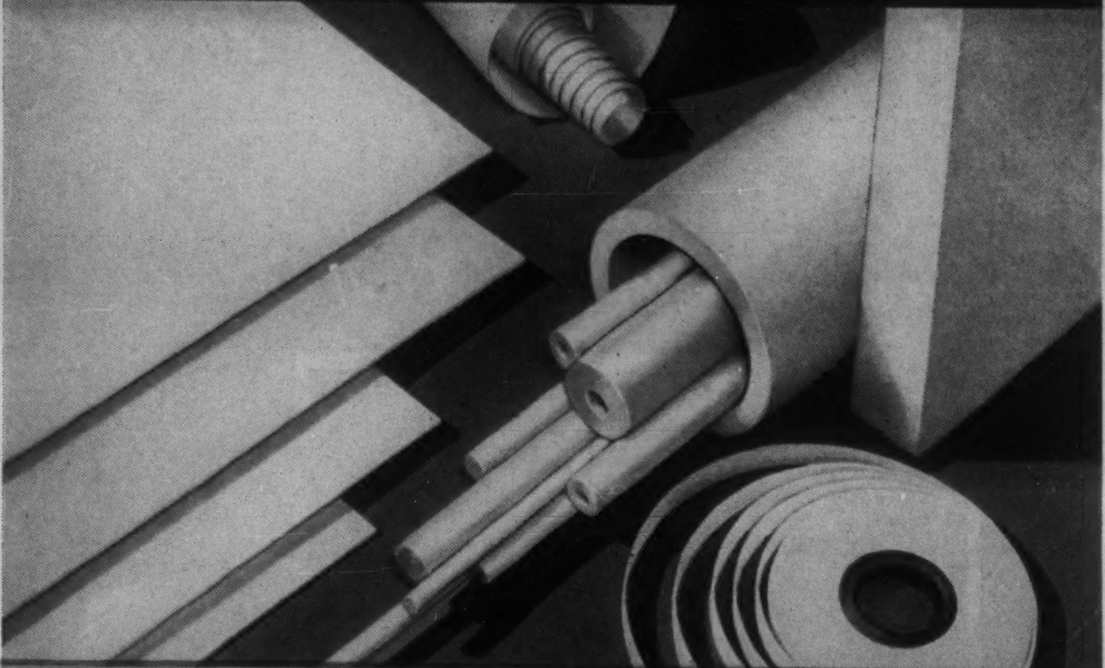

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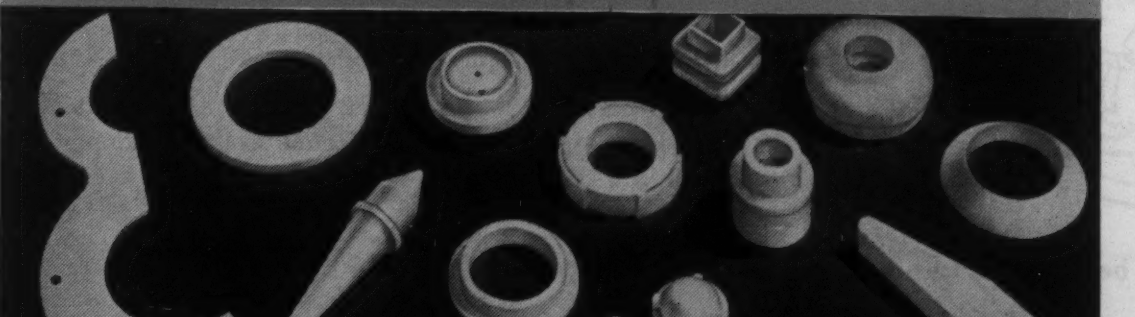

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Technical Reports on Materials

Ferrous

Some Problems of the Theory of Creep. *Y. N. Rabotnov, 1948. NACA TM 1353, 19 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Wash. 25, D. C.* Translated from the Russian.

Influence of Nitrogen on Some Properties of Experimental Steels without and with Boron. *1944. Report PB 108377, 60 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D. C.*

Nonferrous

The Creep of Single Crystals of Aluminum. *R. D. Johnson, F. R. Shober and A. D. Schwope, Battelle Memorial Institute, 1953. NACA TN 2945, 51 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Wash. 25, D. C.* Study conducted in the temperature range from room temperature to 400 F.

Combined-Stress Fatigue Strength of 76s-t61 Aluminum Alloy with Superimposed Mean Stresses and Corrections for Yielding. *William N. Findley, Univ. of Illinois, 1953. NACA TN 2924, 90 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Wash. 25, D. C.*

Axial-Load Fatigue Properties of 24S-T and 75S-T Aluminum Alloy as Determined in Several Laboratories. *H. J. Grover and W. S. Hyler, Battelle Memorial Institute; Paul Kuhn and Charles B. Landers, Langley Aeronautical Laboratory; and F. M. Howell, Aluminum Co. of America, 1953. NACA TN 2928, 63 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Wash. 25, D. C.*

Substitutes for Beryllium-Copper Alloys. *National Research Council, 1952. Report PB 108833, 35 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $2.25, photostat $5.00. (Limited supply available from Minerals and Metals Advisory Board, National Research Council, 2101 Constitution Ave Wash. 25, D. C.)*

Surface Hardening of Titanium B Carburizing and Induction Hea Treating. *Battelle Memorial Institute, 1952. Report PB 108892, 45 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $2.50, photostat $6.25.* In period covered by this report, main attention was given to carburizing in attempt to find surface warranting wear testing.

(continued on page 214)

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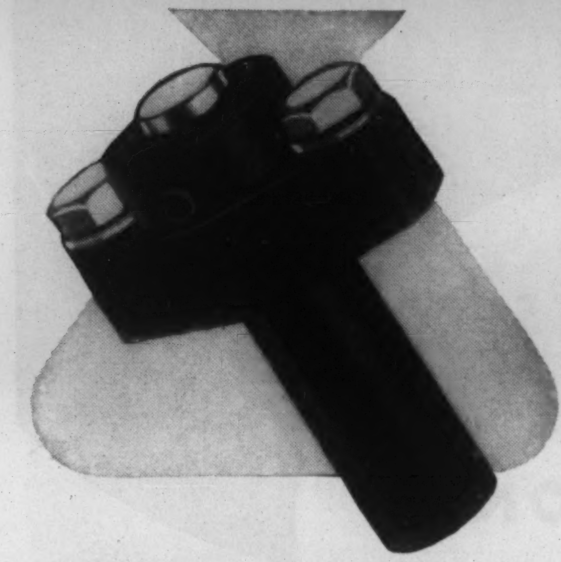

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METAL FINISHING SPECIALISTS

continued from page 212

Nonmetallics

Moisture Relations of Composite Wood Products. The Movement of Plywood (Part iv). Progress Report 23. *R. J. Newall and G. E. Soane, Forest Products Research Laboratory, Gt. Britain, 1953. Report N-21249, 4 pp. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

Manufacture and Properties of Paper Made from Ceramic Fibers. *U. S. Naval Research Laboratory. Report PB 111075, 8 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D. C. Mimeo $.25.* Paper formed from pure fiber had excellent electrical properties but was mechanically weak. Use of clay filler produced stronger paper which could be given desirable electrical properties by dipping in a suitable varnish or impregnating with resins.

Development of Sizings for Glass Fabric in Polyester-Resin Laminates. *Bjorksten Research Laboratories, Inc., 1951. Report PB 107770s, 75 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $3.50, photostat $10.00.* Improved performance with new sizing of vinyl trichlorosilane in conjunction with beta chlorallyl alcohol.

Thermionic Emission of Various Materials. *Battelle Memorial Institute, 1951. Report PB 108488, 111 pp. Microfilm $4.75, photostat $15. Available from Library of Congress, Publication Board Project, Wash. 25, D. C.* Material studied was soda-lime-silica glass.

Heat Resistant Laminating Resins. *U. S. Rubber Co., 1952. Report PB 108757, 35 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $2.25, photostat $5.00.* New low pressure laminating resins based on triallyl cyanurate.

Parts and Forms

Evaluation of Contacts. Final Engineering Report. *P. R. Mallory & Co., Inc., 1951. Vol. I, PB 108475, 351 pp. microfilm $9, photostat $45. Vol. II, PB 108476, 433 pp, microfilm $9, photostat $45. Available from Library of Congress. Publication Board Project, Wash. 25, D.C.* Selection of a contact material or atmosphere can only be made on the basis of the loads involved. Hydrogen is the best heavy current atmosphere and is better at high pressure. Tungsten, molybdenum and

(continued on page 216)

Forgings Replaced WITH EpCo

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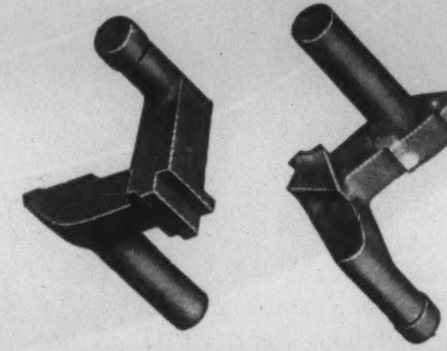

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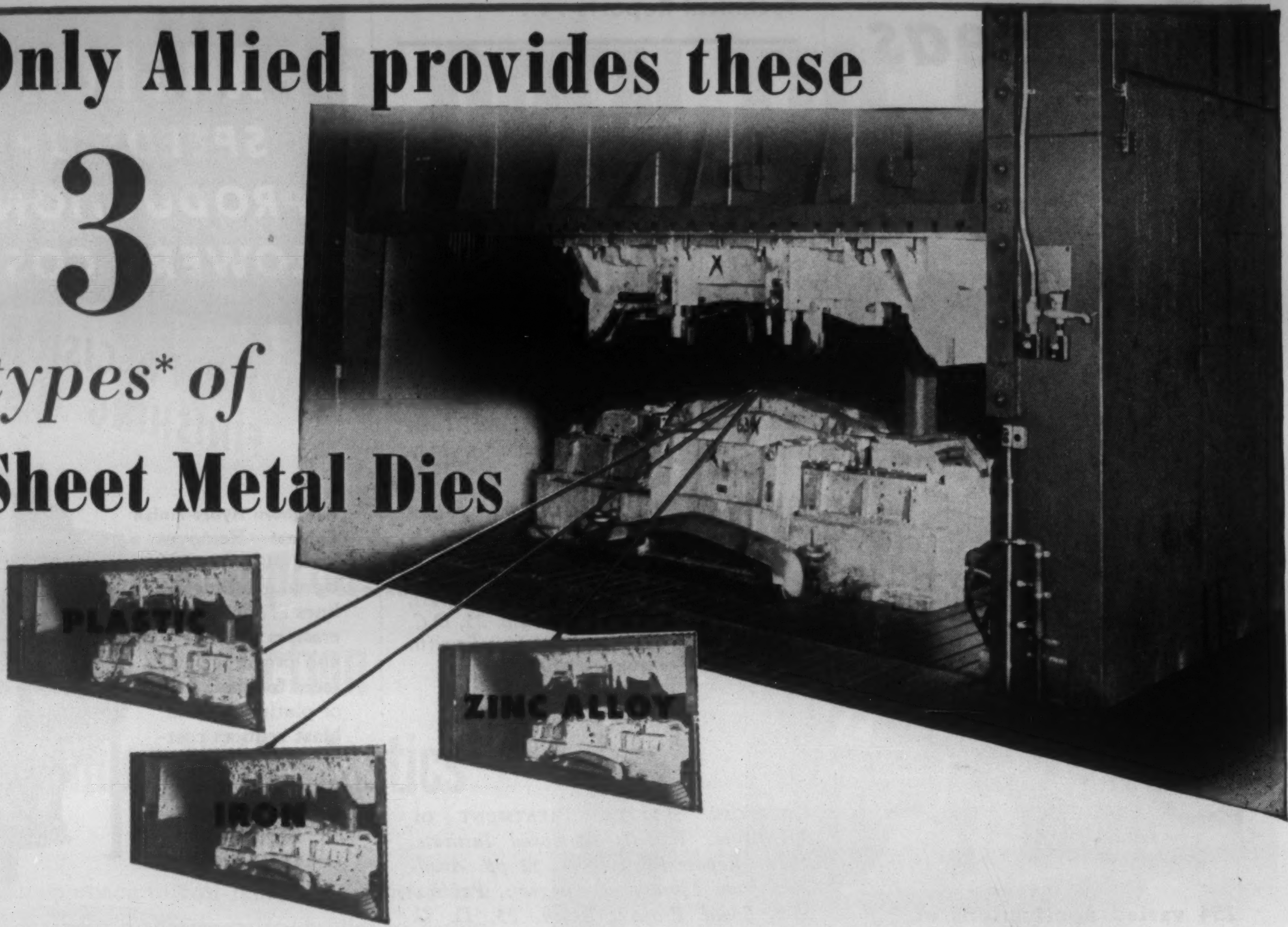

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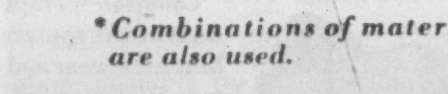
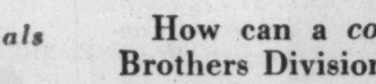
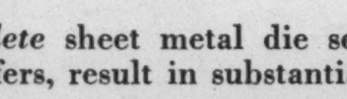


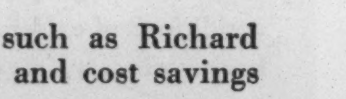
PLANT 1
Detroit, Mich.



PLANT 2
Detroit, Mich.

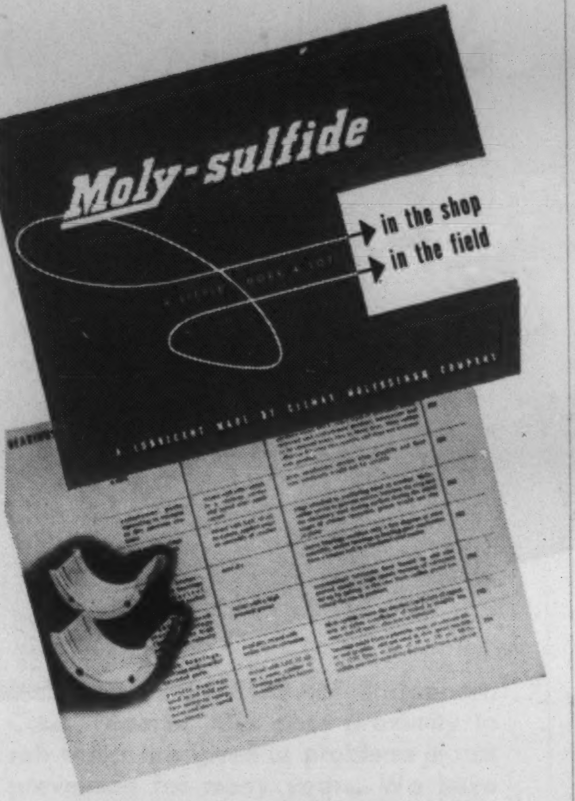


PLANT 3
Hillsdale, Mich.



PLANT 4
Hillsdale, Mich.

154 ideas on ways to use...



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Technical Reports . . .

continued from page 214

silver-cadmium oxide are the best heavy current d.c. materials. Silver is the best material under heavy current a.c. loads. Wide variations in material under lower power loads.

COLLOQUIUM ON TRANSISTORS IN THEORY AND PRACTICE. *U. S. Naval Research Laboratory. Report PB 111086, 40 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D. C. Mimeo $1.00.* Three papers given at a symposium in May, 1952.

SEARCH FOR NEW RESISTIVE MATERIALS FOR HIGH-STABILITY, HIGH-TEMPERATURE-OPERATING RESISTORS. *Battelle Memorial Institute, 1952. Report PB 108309, 22 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2, photostat $3.75.* Twelfth quarterly engineering report.

Coatings

CHEMICAL SURFACE TREATMENT OF TITANIUM. *Battelle Memorial Institute, 1952. Report PB 108891, 52 pp. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $2.75, photostat $7.50.* Testing of various aqueous solutions which might form coatings on titanium.

VINYL ACETATE EMULSION PAINTS. *Translated by P. W. Blaylock and A. H. Andersen, Canadian Dept. of Reconstruction. I. G. Farbenindustrie A. G., 1945. Report PB 99911t, 13 pp. Microfilm $1.75, photostat $2.50. Available from Library of Congress, Publication Board Project, Wash. 25, D. C.*

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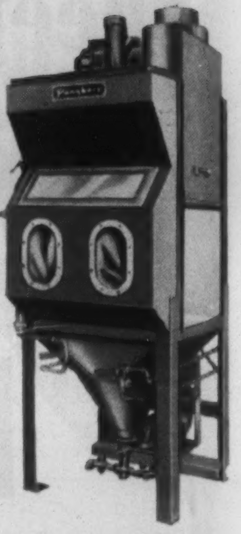

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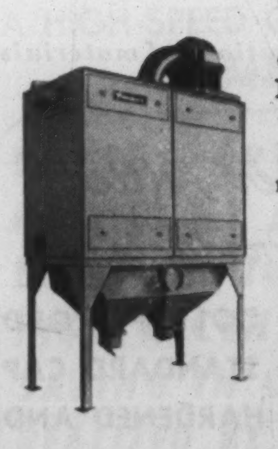

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New design approach explores production economies with plastics

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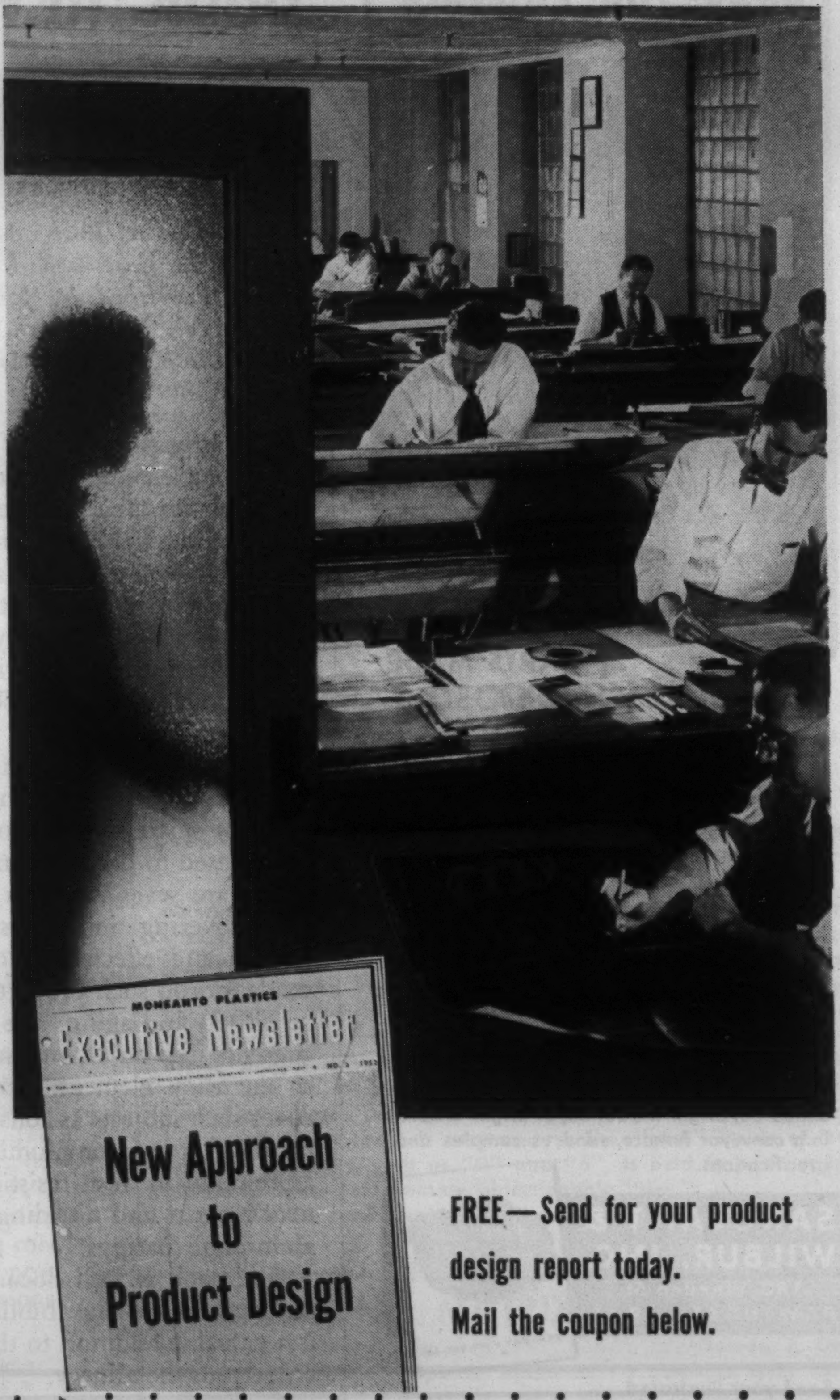

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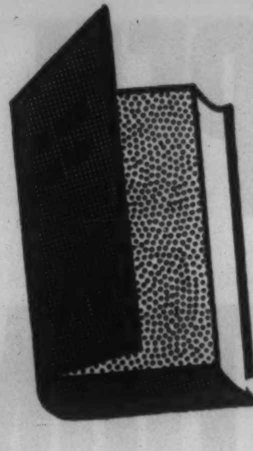

BOOK REVIEWS

Aluminum As Alloying Element

Aluminum in Iron and Steel. *By Samuel L. Case and Kent R. Van Horn. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1953. Cloth, 6 by 9 in. 478 pp. Price $8.50.*

The original *Alloys of Iron* monographs have received world-wide recognition for their comprehensive coverage of the field. *Aluminum in Iron and Steel* is the first in a new series of monographs on selected elements which were of relatively minor interest when the first series was projected, but have increased in importance since that time.

The book is divided into two parts: The first deals with the favorable effect of small additions of aluminum when used to deoxidize molten steel. There are seven chapters in this section covering inclusions, grain-size control and effects of aluminum deoxidation on such properties as notch sensitivity and aging. The second part presents data on aluminum when used as an alloy element. Chapters here cover such subjects as constitution and manufacture of iron-aluminum alloys; aluminum in heat-resisting, permanent magnet and nitriding steels, and aluminum coatings.

The book is well documented and contains an 18-page bibliography. It is a valuable addition to the literature on ferrous metallurgy.

Other New Books

WelDesign. *Published by The Lincoln Electric Co., Cleveland 17, Ohio, 1953. Price $10.00.* The Lincoln Electric Company is now making available new, previously unpublished information on its systems of WelDesign which is a new approach to making better

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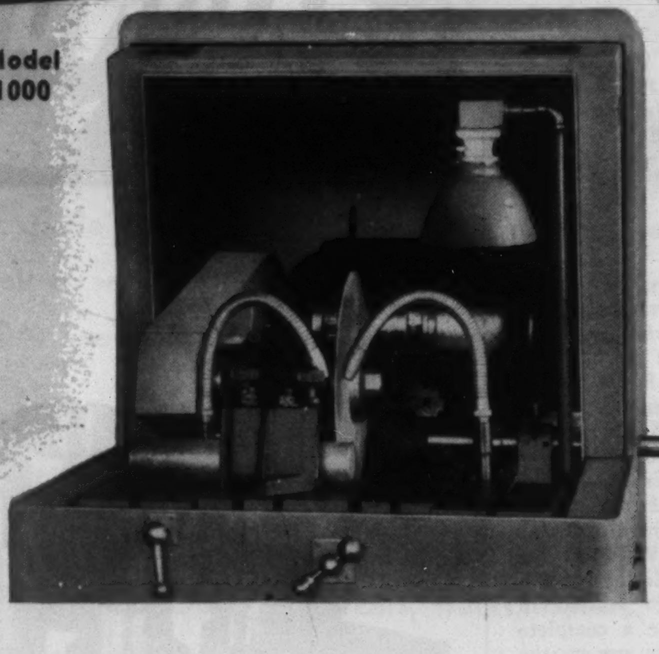

The Buehler Cut-off Machine No. 1000 is a solidly built heavy duty machine free from vibration and side play with capacity for cutting specimen sections up to 3½".

Cutting is done on the front of the wheel and is controlled by a convenient outside lever. With the cover closed, the cutting operation can be viewed through a heavy wired glass window. Regular equipment includes 3 HP totally enclosed ball bearing motor 1750 r.p.m., 220 v., 60 cycle, AC, 3 phase; pump motor ¼ HP, 220 v., 60 cycle, 1 phase; six cut-off wheels 12" x 3/32" x 1¼". Wheels not in use are stored in a spacious compartment in the base, which also contains a removable sludge collection chamber. The self-contained cooling system provides a flood of water for cool cutting. Overall dimensions 31" x 47" x 64". Shipping weight, 1400 pounds.

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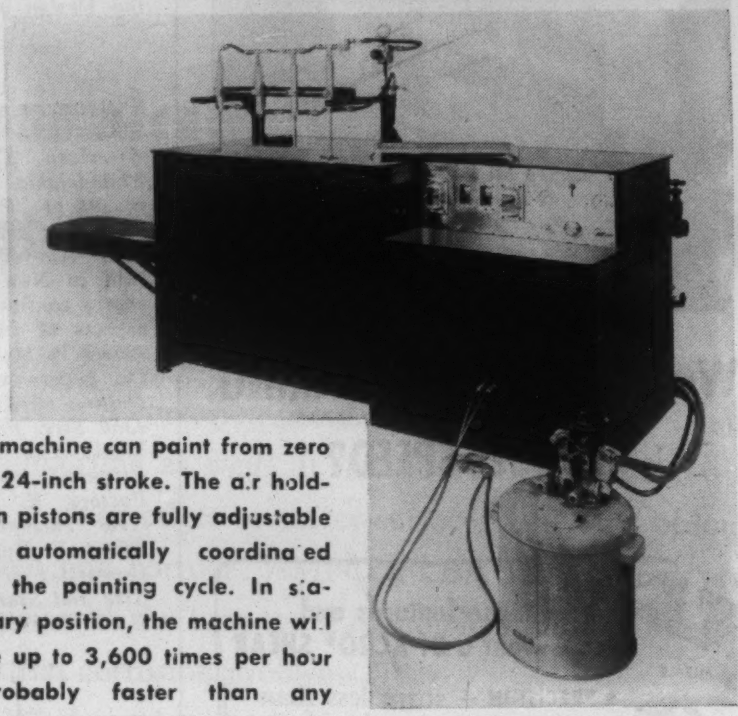

This machine can paint from zero to a 24-inch stroke. The air hold-down pistons are fully adjustable and automatically coordinated with the painting cycle. In stationary position, the machine will cycle up to 3,600 times per hour —probably faster than any operator could handle the parts.

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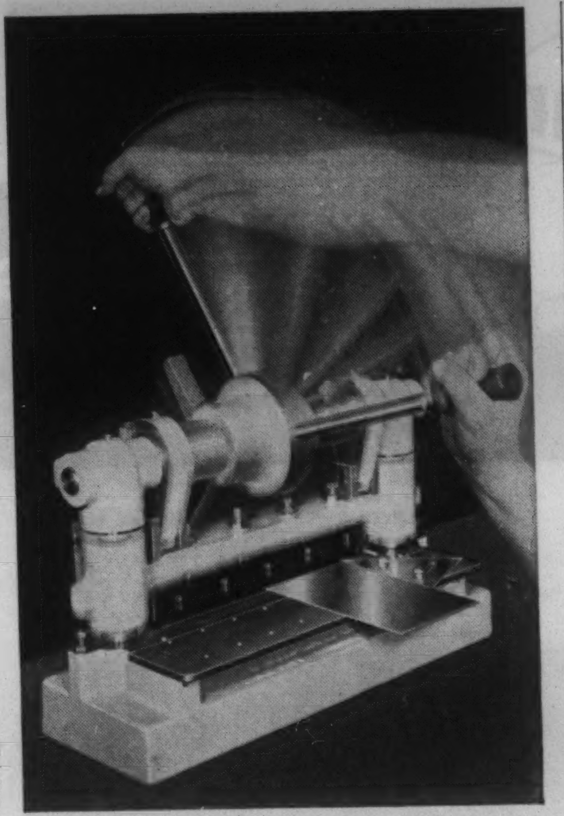

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Book Reviews

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SYMPOSIUM ON FATIGUE WITH EMPHASIS ON STATISTICAL APPROACH—II. *Published by American Society for Testing Materials, Philadelphia 3, Penna., 1953. Paper, 6 by 9 in. 96 pp. Price $2.00.* The papers presented here were given at the Symposium during the 50th Anniversary Meeting of the Society held in New York City in 1952 and represent a continuation of the subject of statistical aspects of fatigue, Part I having been presented in March, 1952. Titles and authors of the papers are as follows: *The Statistical Nature of The Fatigue Properties of SAE 4330 Steel Forgings,* J. T. Ransom and R. F. Mehl; *The Statistical Behavior of Fatigue Properties and the Influence of Metallurgical Factors,* E. Epremian and R. F. Mehl; *A New Interpretation of the Understressing Effect,* E. Epremian and R. F. Mehl; *Fatigue Properties of Large Specimens with Related Size and Statistical Effects,* O. J. Horger and H. R. Neifert.

HISTORY OF STRENGTH OF MATERIALS. *By Stephen P. Timoshenko. Published by McGraw-Hill Book Co., New York 36, N. Y., 1953. Cloth, 6 by 9 in. 452 pp. Price $10.00.* This book is designed for students of engineering mechanics, who, having knowledge of strength of materials and theory of structures through completion of courses, wish to pursue their research further. Handled chronologically, the text treats the developments of the sciences by periods of history. Within these periods, major contributions made by prominent scientists and engineers are related in brief biographies in order to give a complete picture of developments. Coming up to the present, there are discussions which bring together the progress of strength of materials with the state of engineering educations and with the development of industries in various countries.

ASTM STANDARDS ON LIGHT METALS AND ALLOYS. *Published by American Society for Testing Materials, Philadelphia 3, Penna., 1953, Paper, 6 by 9 in. 216 pp. Price $3.00.* This special compilation of ASTM Standards on Light Metals and Alloys, sponsored by Committee B-7, gives the numerous specifications and tests issued by the ASTM through March, 1953. In addition to the recommended codification there are groups of specifications for aluminum and aluminum-base ingots, castings, bars, rods, wire and shapes, forgings, pipe and tubes, sheet and plate. Specifications for wrought products for electrical purposes include those for bars, various types of electrical conductors, wire, etc.; also a test for resistivity. There are two specifications for filler metal-electrodes and brazing material; and the recommended practice for electroplating is also given.

SYMPOSIUM ON TESTING METAL POWDERS AND METAL POWDER PRODUCTS. *Published by American Society for Testing Materials, Philadelphia 3, Penna., 1953. Paper, 6 by 9 in. 96 pp. Price $2.00.* Titles and authors of papers included in this volume are as follows:

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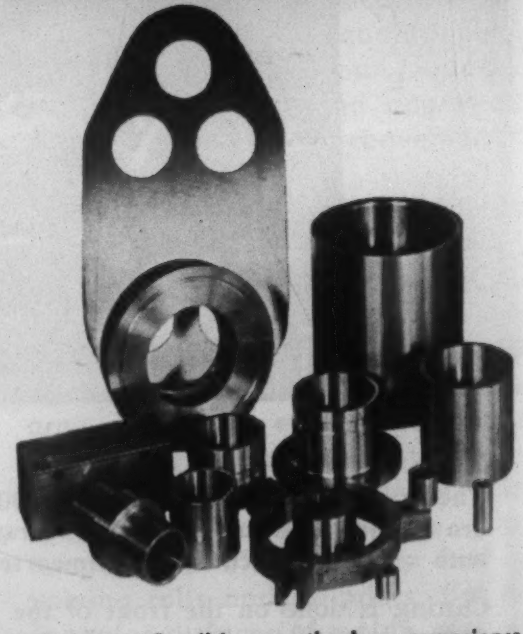
FOR A
BETTER
BEARING?



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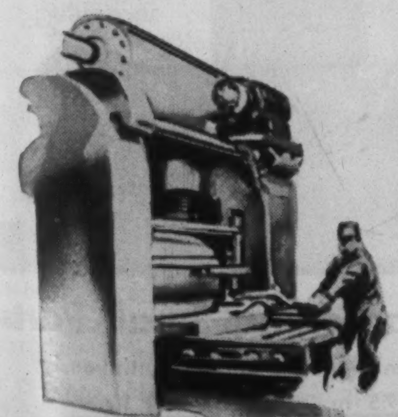

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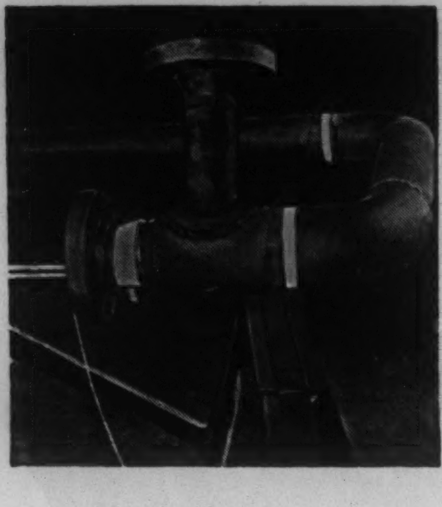
ATLAS Ampcoflex FABRICATIONS



Use

THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

RADIUM

for the tough weld inspection jobs

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Book Reviews

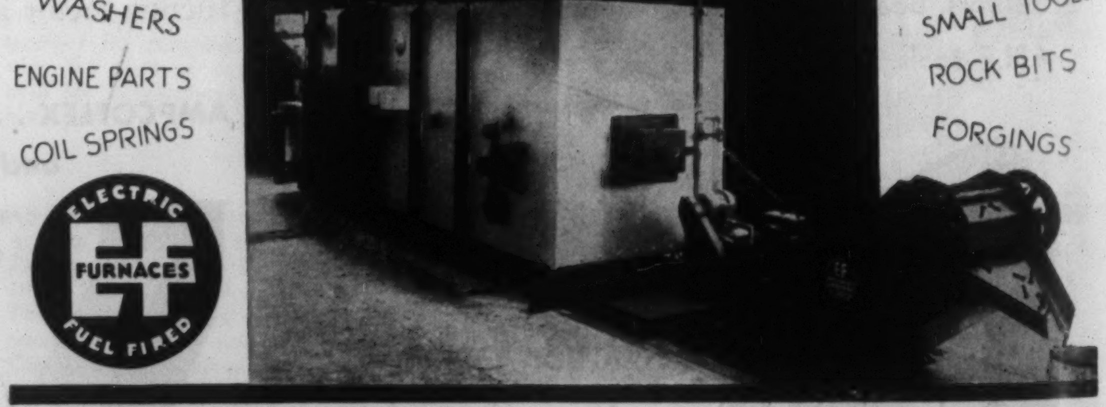
(continued)

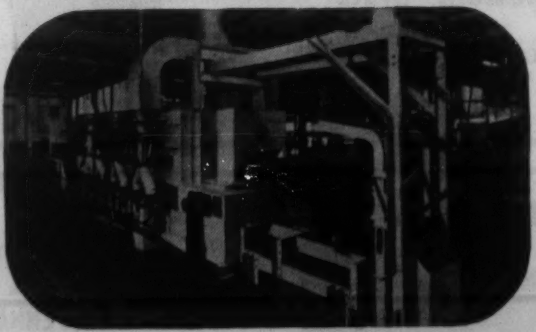
Introduction, F. V. Lenel; *Test Methods and Devices for Sintered Iron Rotating Bands*, John D. Dale; *Quality Control of Metal Powder Gears*, W. A. Hinkle; *Porous Stainless Steel Compacts for Transpiration Cooling*, F. V. Lenel and O. W. Reen; *Methods of Testing Cemented Carbide Compositions*, Alfred D. Stevens and John C. Redmond; *Metal Powder Size Distribution with the Roller Air Analyzer*, Paul S. Roller; *Metal Powder Particle Size Determination*, Richard P. Seelig; *Some Experiences in Specific Surface Measurement of Metal Powders by Low Temperature Gas Adsorption*, J. B. Haertlein and J. F. Sachse.

BORON STEEL. *Edited by Ernest E. Thum. Published by American Society for Metals, Cleveland 3, Ohio, 1953. Paper 8½ by 11 in. 114 pp. Price $1.00.* This revised 1953 edition contains papers on such topics as Company experience with boron steels and effect of boron on steel. A Supplement on Hardenability Test, H-Steels, and Their Use is also offered. Detailed graphs, tables and diagrams accompany the information.

METAL CLEANING BIBLIOGRAPHICAL ABSTRACTS 1842-1951. *Published by American Society for Testing Materials, Philadelphia 3, Penna., 1953. Paper, 6 by 9 in. 136 pp. Price $4.25.* These abstracts are intended to make the published data on metal cleaning readily available to those persons connected with the production, finishing, and maintenance of metal products. The publication is a result of the intensive efforts of Jay C. Harris of Monsanto Chemical Co. in collecting, arranging and indexing over 1,000 annotated references to the literature on metal cleaning. The information is presented here in a most useful manner. The references are arranged by year, and secondarily by author, or by the journal in which the article appeared if anonymous, and are numbered consecutively. The abstracts have been thoroughly indexed in the following four ways: Subject Index, Author Index, Specification Index, and Patent Index.

REPORT ON SURFACE PREPARATION OF STEELS FOR ORGANIC AND OTHER PROTECTIVE COATINGS. *Published by National Association of Corrosion Engineers, Houston 2, Texas, 1953. Paper, 8 by 11 in. 12 pp. Price $1.00 each, or 5 or more copies at 50¢ each.* This is the second interim report published by Technical Practices Subcommittee 6-G. It covers recommendations and explains methods whereby the surfaces of steel may be prepared for painting with organic and other coatings by means of weathering, wire brushing, grinding, flame conditioning, nozzle blast cleaning both wet and dry, wheel blasting, chemical pickling, electrolytic pickling, surface conditioning and numerous other related methods. Accepted standards are discussed and safety measures indicated.





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Brass & Bronze Co., 72 pp, ill, No. 52. A complete presentation of this company's standard stock bearings, graphited oilless bearings, precision bronze bars, and electric motor bearings. (62)

Cemented Chromium Carbide. Carboloy Dept., General Electric Co., 12 pp, ill, No. CC-100. Technical data on Carboloy Grade 608 cemented chromium carbide, which is highly resistant to corrosion and erosion. (63)

Punch and Die Setting Alloy. Cerro de Pasco Corp., 20 pp, ill, No. A15. Properties and description of use of Cerromatrix for setting various types of dies and punches. Shows advantages over solid dies. (64)

Thermostatic Bimetals. W. M. Chace Co., 8 pp, ill. Paper on the fundamentals of bimetal performance, which was presented recently at the AIEE Appliance Technical Conference. (65)

Enamelled Metal Strip. Coated Coils Corp., 4 pp, ill. Describes coiled enamelled metal strip supplied in widths up to 30 in. which can be put through forming operations without damaging the coating. (66)

Die Cast Parts. Dollin Corp. Bulletin describes advantages of using this company's facilities for production of small zinc or aluminum precision cast parts. (67)

Nickel Alloy Products. Driver-Harris Co., 4 pp, ill. "D-H Alloy Craftman" describes various applications of Nichrome and monel wires and forms. (68)

Copper-Clad Aluminum Bi-Metal. Eastern Brass & Copper Co., Inc., 8 pp, ill. Technical data on Eastmetal, a new copper-clad aluminum bi-metal available in sheet or bus bar form, are presented in a 4-page bulletin, plus a 4-page reprint on how copper-clad aluminum can conserve copper. (69)

Castings. Eclipse-Pioneer Div. Foundries, Bendix Aviation Corp., 4 pp, ill. Discusses facilities of this company for producing a variety of sand, die and permanent mold castings of magnesium and aluminum. (70)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (71)

Aluminum Alloy. Frontier Bronze Corp. Data on Frontier 40-E aluminum alloy combining high strength, good shock and corrosion resistance and machinability. (72)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision cast bronze, brass, beryllium-copper and steel. (73)

Zinc Die Castings. Gries Reproducer Corp., 4 pp, ill. Specifications of corrosion resistant nonferrous zinc alloy wing nuts, small zinc die castings and injection moldings. (74)

Perforated Materials. The Harrington & King Perforating Co., No. 62. Catalog gives data on fabrication methods, how to order, types of perforation and uses of perforated materials. (75)

Die Castings. Hoover Co., 12 pp, ill, No. 853. Shows this company's facilities for producing zinc and aluminum die castings. Includes design helps, describes applications. (76)

Illium Alloy. Illium Corp., 4 pp, ill, No. 651. Complete data on physical and mechanical properties, advantages and applications of both Illium G and Illium R. (77)

Bearing Design. Johnson Bronze Co. Data sheets give information on proper design of bearings, including details such as the lubrication of sleeve type bearings. (78)

Silicon Bronze. R. Lavin & Sons, Inc., 8 pp, ill, Vol. 9, No. 1. "The Lavingot" contains an interesting article on the subject of silicon bronze. (79)

Titanium and Its Alloys. Mallory-Sharon Titanium Corp., 16 pp, ill. Presents general properties, standard product classifications, testing procedures and properties of the five types of titanium and titanium alloys produced by this company. (80)

Ferrous and Nonferrous Metal Forms. Metal Goods Corp., 274 pp. Complete stock list and ordering information on metal parts and forms supplied by this company. (81)

Die Castings. Monarch Aluminum Mfg. Co. File data on aluminum and zinc die castings and aluminum mold castings showing applications, advantages and this company's facilities for making them. (82)

Zinc. New Jersey Zinc Co., 8 pp, ill. The Dec. 1952 issue of "Horse Head Bulletin" features brief articles on spinning zinc, zinc oxide in pelleted forms, and erecting a steel headframe on a zinc mine. (83)

Self-Lubricating Bearings. O & S Bearing Co., 4 pp, ill, No. 151. Complete data on the use of O & S self-lubricating bearings in a wide variety of applications. (84)

Bushings. Randall Graphite Bearings, Inc., 12 pp, ill, No. 100. Complete price list of bronze bushings and specially grooved bushings; specifications of bored and solid bronze bars. (85)

Titanium and Its Alloys. Republic Steel Corp., 32 pp, ill, No. 588. A practical working manual presenting some basic and fairly well substantiated data on commercial quality titanium and its alloys. (86)

Lockseam Tubes. Revere Copper and Brass, Inc., 46 pp, ill. Contains comprehensive listing of more than 100 shapes of lockseam tube and rolled moldings of interest to manufacturers in the automotive, house furnishings, hardware and farm implement fields. (87)

Aluminum Bonded to Steel. Arthur Tickle Engineering Works, 8 pp, ill. Describes process for molecular bonding of aluminum to iron and steel, its applications and advantages. (88)

Sintered Metal Parts. U. S. Graphite Co., 40 pp, ill, No. G-53. Attractively presents facilities of this company for producing a wide variety of Gramix high quality, low-cost sintered metal parts. (89)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (91)

Nonmetallic Materials • Parts • Forms

Molybdenum Disulfide as a Lubricant. The Alpha Corp., 4 pp, ill. Reprint discusses the properties and uses of pure molybdenum disulfide as a lubricant. (92)

Polyvinyl Chloride. American Agile Corp., Plastics Div., 18 pp, ill. Discusses physical and chemical properties of Agilene (polyethylene) and its many fabricated products. (93)

Filter Mat. American Felt Co., 6 pp, ill. Technical data and sample of Dynel Windsor Felt, a new fiber-bonded filter mat for use in filter press or vacuum filter applications. (94)

Heat Resistant Hard Rubber. American Hard Rubber Co., 4 pp, No. 96-B. Describes Ace Tempron, a new heat resistant synthetic hard rubber compound available as molded parts, in sheet, rod and tubing, and standard pipe and fittings. (95)

Metal Sealer. American Metaseal Mfg. Corp., 8 pp, ill, No. MMC-048. Advantages, properties and applications of Metaseal 19V5 for sealing castings. (96)

Protective Papers. Angier Corp., 16 pp, ill. Describes typical applications of various protective papers produced by this company for industrial packaging. (97)

Gasket Materials. Armstrong Cork Co., 24 pp, ill. Complete data on various cork and rubber gasket materials made to meet government specifications. (98)

Glass Fiber Sleeving. Bentley, Harris Mfg. Co., 4 pp. Describes new Fiberglas tubing and sleeving with high physical and dielectric properties. (99)

Plastic Molding Material. Bolta Products Sales, Inc., 4 pp, ill. Gives characteristics and advantages of Boltaron plastic molding material designed for low cost molding. (100)

Molding Compounds, Resins and Cements. The Borden Co., Chemical Div., 8 pp, ill, No. 10M. General properties and uses of Durite specially prepared phenolic molding compounds, resins and cements. (101)

Plastic Pipe. Carlon Products Corp., 4 pp, ill. Contains factual informative answers to most frequently asked questions about Carlon flexible plastic pipe and Carlon rigid pipe. (102)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, ill. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (103)

Engineered Paper Products. Cincinnati Industries, Inc., 16 pp, ill. Complete data on the new double crepe Cindus material called X-Crepe that can be used like cloth, instead of rubber, in place of cork, and for jobs where no other material will do. (104)

Custom Extrusions. Conneaut Rubber & Plastics Co., 4 pp, ill, No. CR-53. Facilities of this company for producing a variety of precision-made extrusions. (105)

High Strength Plastics. Continental-Diamond Fibre Co., No. GF-50. Properties, descriptions and applications of five of this company's high strength plastics. (106)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Gives dimensions of molded and extruded rubber with cross sectional illustrations. Also condensed SAE and ASTM specifications chart. (107)

Glass Electrical Products. Corning Glass Works, 8 pp, ill, No. B-88. Electrical applications of various types of glass. Includes tables of electrical and physical glass prop-

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erties. (108)

Plastic. Crane Packing Co., 12 pp, ill, No. T-103. Complete data on Chemlon packings and gaskets fabricated from the new tetrafluorethlyene resin, Teflon. (109)

Teflon Plastic. Dixon Saddle Co., 3 pp. Chemical, electrical and nonadhesive properties of Teflon, which is available in rods and tubes and can be extruded to any desired length. (110)

Polystyrenes. Dow Chemical Co., 8 pp. Complete date on the various Styron formulations with regard to properties, methods of molding, and applications. (111)

Glass Products. Dunbar Glass Corp., 4 pp, ill. Description of this firm's various industrial glasses. Explains advantages of glass to the designer and gives physical properties. (112)

Rubber. E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Div., 8 pp, ill, No. 54. "Neoprene Notebook" No. 54 contains the first of a series of articles on the fundamentals of rubber testing and terminology. (113)

Synthetic Elastic Compositions. E. I. du Pont de Nemours & Co. (Inc.), Fabrics Div., 8 pp, ill, No. A-3304. Features a detailed table of physical properties of Fairprene synthetic elastic compositions. (115)

Casting Resin. Durez Plastics & Chemicals, Inc., 16 pp, ill. Technical discussion of Durez 7421A, a phenolic casting resin in liquid form. Includes instructions for use. (116)

Dry Coloring Polyester Resins. Ferro Corp., 2 pp. Explains types of colors manufactured by Ferro that can be used in the dry state. (117)

Vinyl Resins. Firestone Plastics Co., Chemical Sales Div., 17 pp. Description and physical properties of Exon vinyl resins. Also test procedures to determine volatile matter, relative viscosity and heat stability. (118)

Plastic Laminates. Formica Co., 4 pp, No. 303. Detailed chart giving the comparative properties of a complete line of plastic laminates produced by this company. (119)

Plastics Parts. Franklin Plastics, Div. of Robinson Industries, Inc., 6 pp, ill. Illustrates variety of plastics products and discusses this company's injection molding facilities. (120)

Neoprene Cold Bond System. Gates Engineering Co., 4 pp, ill, No. N-4. Advantages and properties of the Gaco cold bond system for bonding cured Neoprene sheet to metal, wood and concrete. (121)

Plastics Products. General American Transportation Corp., Plastics Div., 10 pp, ill. Brochure shows plant facilities for production from blueprint through assembly and packing. Also lists wide variety of this company's molded plastics. (122)

Industrial Laminates. General Electric Co., Chemical Div., 8 pp, ill, No. COL-82. Complete technical data on a variety of Textolite industrial laminates produced by G-E. (123)

Plastics. General Industries Co., 16 pp, ill. Profusely illustrates the facilities of this company for producing a wide variety of low-cost custom-molded plastics. (124)

Rubber-to-Metal Adhesive. General Tire & Rubber Co., Chemical Div., 8 pp, ill, No. 4016. Complete data on Kalabond rubber-to-metal adhesive for non-corrosive solvent-resistant bonding. (125)

Insulating Sheet. Glastic Corp., ill. Property data and comparison charts on Glastic MM, Fiberglas reinforced laminate with high strength and heat resistance for electrical insulation. (126)

Vibration Eliminator. B. F. Goodrich Co., 4 pp, ill, No. 7290. Includes installation instructions of the Goodrich Vibropad which muffles shock, noise and vibration of heavy equipment. (127)

Polyvinyl Resins. B. F. Goodrich Chemical Co., 12 pp, ill. Case histories describe packing problems of typical users of Geon resin coatings and films and solutions provided by these materials. (128)

Polyvinyl Chloride Resins. Goodyear Tire & Rubber Co., Chemical Div., 14 pp, Nos. PVR-100-6 and 7. Two "Techni-Guides" contain informative data on Pliovic G90V and G80V polyvinyl chloride resins. (129)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill, No. 108. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (130)

Cellular Rubber Parts. Great American Industries, Inc., Rubatex Div., 12 pp, ill, No. RBS. Describes properties, uses and advantages of Rubatex closed cell rubber and facilities for making odd shapes to order. (131)

Polyvinyl Chloride. H. N. Hartwell & Son, Inc., 6 pp, ill, Nos. 2B and PF. Data sheet and basic information on Boltaron 6200, a nonplasticized polyvinyl chloride. (132)

Plastics. Heil Process Equipment Corp., 3 pp, ill, Nos. 752, 753 and 754. Discusses the use of Rigidon plastics exhaust heads, duct fittings and ventilating ducts. Specifications included. (133)

Molded Plywood. Keller Products, Inc., 12 pp, ill. Booklet describes standard and constantly used die shapes for molding plywood as an aid to designers of molded plywood shapes. (134)

Polystyrenes. Koppers Co., Inc., 2 pp, No. C-2-169. Features a table giving all the properties of a complete line of straight and modified Koppers polystyrenes. (135)

Mechanical Rubber Goods. Lavelle Rubber Co., 424 N. Wood St., Chicago 22, Ill., 60 pp, ill, No. MS52. A comprehensive design guide and catalog listing a variety of mechanical rubber goods, and including characteristics and recommended usage. Request direct from Lavelle on company letterhead.

Electrical Insulation. Louthan Mfg. Co., 13 pp, ill, No. 49-E. Uses and specifications of Louthan insulations in mechanical, electrical, thermal and electronic fields. (136)

Plastics Molding. P. R. Mallory Plastics, Inc., 4 pp, ill. Complete production facilities for large scale production of custom-molded parts from design to finishing and assembly. (137)

Industrial Porcelains. McDaniel Refractory Porcelain Co., 24 pp, ill. Descriptions, outstanding features and specifications of various types of industrial porcelain parts. (138)

Glass Products. McKee Glass Co., 16 pp, ill, No. 12-68. Describes types of glasses manufactured, their applications and facilities for large-scale production. Illustrates numerous products for home and industry, including electrical, laboratory, television and marine equipment. (139)

Carbon Products. Morganite, Inc., 8 pp, ill, No. 1f. Specifications of various carbon bearings and bushings. Also properties of six series of Morganite carbon products. (140)

Structural Plastic. Narmco, Inc., 8 pp, ill. Properties, applications and facilities of this company for producing Conolon, a structural plastic that is lightweight but strong and tough. (141)

Molding and Extrusion Compounds. Naugatuck Chemical Div., 3 pp. Folder of technical data sheets on properties, features, uses and handling methods of Kralastics, plastic and elastomeric combinations. (142)

Molded Nylon Parts. Nylon Molded Products Corp., 4 pp, ill. Illustrates and describes various nylon parts for plastic applications. Includes physical properties chart. (143)

Rubber. Ohio Rubber Co., 4 pp, ill, No. F-426. Detailed tabulation of the properties of natural rubber and rubberlike materials. (144)

Laminated Resinous Plastics. Panelyte Div., St. Regis Sales Corp., 19 pp, ill. Physical properties, industrial and chemical applications and fabrication of laminated thermosetting resinous plastic. (145)

Reinforced Plastics. Plaskon Div., 6 pp, ill. Folder describes molding operation and gives physical properties of fiber-glass reinforced alkyd molding compounds and their uses in home and industry. (146)

Synthetic Flexible Tube Assemblies. Resistoflex Corp., 4 pp, ill. Briefly gives chemical and physical properties obtained with synthetic tubes. Describes types of construction, where to use, and how they solve design problems. (147)

Plastics. The Richardson Co., 2782 Lake St., Melrose Park, Ill., 24 pp, ill, No. 836. "Facts About Plastics" gives basic introduction to plastics, their production and uses in industrial and consumer products. Request direct from Richardson on company letterhead.

Molded Fiber Glass Laminated Plastics. Rolle Mfg. Co., Inc., 16 pp, ill. Profusely illustrates a variety of products molded with Fiberglas laminated plastics. (149)

Molded Rubber Parts. Rubber Products Div., Parker Appliance Co., 4 pp, ill, No. 5201A. Lists the many advantages of using Parker custom molded rubber parts in a variety of applications. (150)

Extrusion of Plastics. Sheffield Plastics, Inc., 2 pp, ill. Describes custom service for producing rods, tubes and other thermoplastic shapes to order. (151)

Plastics. Spaulding Fibre Co., Inc., 8 pp, ill. Presents a detailed list of typical and special applications possible when using Spaulding plastic materials. (152)

Carbon and Graphite Parts. Stackpole Carbon

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Co., No. 40. Shows numerous standard parts and includes helpful data on the selection of carbon-graphite products. (153)

Rubber Parts. Stalwart Rubber Co., 16 pp, ill, No. 51SR-1. Describes applications and fabrication of rubber compounds designed to resist temperature, abrasion, chemicals and weathering. (154)

Printed Circuits. Stupakoff Ceramic and Mfg. Co., 3 pp, No. 1151. Shows representative circuits available in standard Stupakoff printed circuits, together with values of resistors and capacitors. (155)

Thermoplastic. Van Dorn Iron Works Co., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (156)

Felt. Western Felt Works, 32 pp, ill. History of manufacture and uses of felt, including brief description of present-day methods and applications. (157)

Industrial Plastic. Westinghouse Electric Corp., 36 pp, ill, No. B-3184-D. Properties, grades, shapes, sizes, machining and application data on Micarta, an industrial plastic. (158)

Finishes • Cleaning and Finishing

Pickling Acid Inhibitors. American Chemical Paint Co., 4 pp, ill, No. 270B. Lists the many advantages obtained when Rodine is added to acid pickling baths. (159)

Preparing Material for Hot Dip Galvanizing. American Hot Dip Galvanizers Assn., Inc., 4 pp, ill. Recommends the proper preparation of materials prior to hot dip galvanizing. (160)

Metal Cleaners. Apothecaries Hall Co., 4 pp, No. B-8. Complete data on a variety of Ahcoloid Metal Cleaners for soak tanks, electrolytic cleaning, power washers and tumbling barrels. (161)

Protective Coating. Bakelite Co., 16 pp, No. 12. Specifications, formulations and uses of Vinylite Resin VMCH as a surface coating. (162)

Rust-Inhibiting Paint Base. Bell-Ray Chemical Corp., 4 pp. Features advantages of using Chem-Bond, a rust-inhibiting paint base, on iron, steel, brass, copper, aluminum, etc. (163)

Resin-Bonded Laminates for Finishing. The Chemical Corp., 20 pp, ill, No. PD-1R353. Data sheets discuss a variety of tanks, ducts, hoods, stacks and waste pipe for corrosion resistant use. (164)

Spray Painting. Conforming Matrix Corp., 5 pp, ill. Gives description, uses and advantages of this firm's spraying masks, mask washing machine, and spray painting equipment. (165)

Black Oxide Finish. Du-Lite Chemical Corp. Information on Du-Lite finishes for any steel blackening problem. Also gives information on Du-Lite cleaner, strippers, burnishing compounds, etc. (166)

Descaling Process. E. I. du Pont de Nemours & Co., (Inc.), Electrochemicals Dept., 8 pp, ill, No. A-6506. Describes sodium hydride process for descaling metals, advantages and necessary equipment. (167)

Wear Resistant Coating. Electrolyzing Corp., 16 pp. Detailed data on the Electrolyzing Process for increasing the life and efficiency of metal parts subjected to wear, abrasion and corrosion. (168)

Film Clear Resin Coating. R. M. Hollingshead Corp. U. S. Army specification 3-182 gives usage, application, protection, price, etc. on a thin film clear resin coating. (169)

Aluminum Cleaner. Kelite Products, Inc., 2 pp, ill, No. 120. Describes the Kelite Process of preparing aluminum for spotwelding. (170)

Metallizing. Metallizing Co. of America, 20 pp, ill. Describes metallizing process and its usefulness in fighting corrosion, rebuilding worn parts, and reclaiming mis-machined castings. (171)

Colored Silicone Finishes. Midland Industrial Finishes Co., ill. Reprint interestingly discusses the application of colored silicone finishes. (172)

Barrel Finishing. Minnesota Mining & Mfg. Co., 16 pp, ill, No. A-HiB(BFM). Complete data on the Honite barrel finishing method of deburring and burnishing small metal parts. (173)

Pickling Chemical. Mitchell-Bradford Chemical Co., 2 pp. Announces the development of Black Magic Pik-Aide, a chemical solution that is added to hydrochloric (muriatic) sulfuric and nitric acid pickles. (174)

Barrel Finishing Media. Newton Industries Inc., 4 pp, ill. Describes advantages of Polishapes, zinc alloy bodies specially designed for use in barrel finishing processes. (175)

Aluminum Cleaner. Northwest Chemical Co., 10 pp, ill. Attractively presents information on the Alkalume Process for preparing aluminum for spot welding. (176)

Protective Coating. Nox-Rust Chemical Corp., 4 pp, ill. Describes Nox-Rust 310-AC protective coating for metal parts. Easily applied, said to afford good protection up to 90 days. (177)

Electroplating. Oakite Products, Inc., 28 pp, ill. Answers to many questions that affect success of electroplating on steel. (178)

Power Brush Finishing. Osborn Mfg. Co., 12 pp, ill, No. L-272. A comprehensive article covering the important factors in the selection and application of brushes for specific finishes. (179)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Acid Additives for Finishing. Promat Div., Poor & Co., 12 pp. Technical data on the use of Promat acid additives in metal finishing operations. (180)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 225

Mechanical Finishing. Roto-Finish Co. Folder describes uses and economies of Roto-Finish tumbling-type equipment for precision grinding, deburring and coloring metals. (181)

Protective Coatings. Rust Proofing & Metal Finishing Corp., 4 pp. Check list of specialized precision processes of protecting and finishing metals available from this company. (182)

Vacuum Metallizing. F. J. Stokes Machine Co., 13 pp, ill, No. 725. Describes in detail how this low-cost coating process can be applied to plastic, metal, glass and paper surfaces. (183)

Electroplated Rhodium. Technic Inc., 1 p. Technical data sheet on electroplated rhodium also announces the availability of heavy rhodium plated deposits. (184)

Zirconium Glazes for Ceramics. The Titanium Alloy Mfg. Div., 30 pp. Description, uses and properties of TAM zirconium glaze opacifiers. (185)

Wet and Dry Tumbling. Tumb-L-Matic, Inc., No. PC-52. Describes five processes for finishing metal and plastic parts by tumbling parts with abrasive materials in rotating barrels. (186)

Protective Coating. United Chromium Inc., 2 pp, ill, No. RC-2. Properties and uses of Unichrome Coating 218X, a vinyl plastisol material for coating plating and conveyor racks, plating barrels, agitators, etc. (187)

Hard Facing Welding Rod. Wall-Colmonoy Corp., 4 pp, ill, No. 102. Properties, applications and uses of Colmonoy No. 1 hard facing welding rods. (188)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (189)

Heat Treating • Heating

Induction Furnaces. Ajax Engineering Corp. Information on Ajax-Tama-Wyatt induction furnaces for melting metals with accurate temperature control and freedom from contamination. (190)

Heat Treating Furnaces. A. D. Alpine Inc., 4 pp, ill. Gives features and specifications of six Contro-Therm heat treating furnaces for all types of heat treating, soldering and brazing. (191)

Salt Baths. American Cyanamid Co., 16 pp, ill, No. 544-4. Features case histories of several companies who employed Cyanamid's heat treating compounds with Cyanamid technical service. A list of the compounds and their properties are included. (192)

Case Hardening Process. American Gas Furnace Co. Principles of "Ni-Carb" case-hardening, its advantages, and descriptions of AGF furnaces for the process. (193)

Heat Treating Equipment. Gas Appliance Service Inc., 7 pp, ill. Shows standard and special equipment for heat treating and gives

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typical applications for each type of furnace. (194)

Rotary Hearth Furnaces. Gas Machinery Co., 4 pp, ill, No. A-102. Complete specifications of the Gasmaco rotary hearth furnaces for forging, annealing, heat treating or drawing operations. (195)

Electric Furnaces. Harper Electric Furnace Corp., 4 pp, ill, No. 252. Presents features and specifications of furnaces for all types of research and small scale production. (196)

Salt Baths with Additives. A. F. Holden Co., 4 pp. Complete data on a new series of six neutral salt baths with additives. (197)

Heat Treating Furnaces. Industrial Heating Dept., Westinghouse Electric Corp., 38 pp, ill, B-5459. Complete description of Westinghouse furnaces—large and small, gas and electric. (198)

Process Heating. Jensen Specialties, Inc., 4 pp, ill. The first issue of a new bi-monthly, "Heat Lines", covering technical data and tips on process heating. (199)

Tube Elements for High Temperature Furnaces. Kanthal Corp., 9 pp. Applications, construction and specifications of Kanthal tube elements for high temperature furnaces used in ceramics, chemical, glass and metal industries. (200)

High Frequency Heating Units. Lepel High Frequency Laboratories, No. MM-7. Specifications, features and advantages of this company's low cost, high frequency heating units. (201)

Induction Heating Units. Lindberg Engineering Co., No. 1440. Descriptions and applications of this firm's induction heating units, said to give rapid, dependable operation on large or small parts. (202)

Induction Heating. Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (203)

Salt Bath. Park Chemical Co., No. H-1, Specific application recommendations on the Neutra-Gas Process, an efficient and economical method of maintaining absolute neutrality in chloride-base salt baths. (204)

Electric Furnaces. Pereny Equipment Co., 3 pp, ill, No. 4A. Booklet tells advantages and illustrates typical group of this company's furnaces and kilns and their uses. (205)

Hardening Furnaces. Surface Combustion Corp., 4 pp, ill, No. SC-161. Features a variety of gas-fired, batch type standard rated furnaces for hardening operations. (206)

Portable-Base Convector Furnaces. Lee Wilson Engineering Co., Inc., 19 pp, ill. Features and advantages of the new portable-base single-stack furnace. (207)

Welding • Joining

Brazing Alloys. The American Platinum Works, 46 pp, ill. Handy-sized manual gives detailed description of the brazing process, the alloys used, design of joints and other considerations for successful joining. (208)

Resistance Welding Alloys and Electrodes. Ampco Metal Inc., 24 pp, ill, No. RW-1a. Physical properties, applications and specifications of a complete line of Ampco-Weld products for resistance welding. (209)

Alloy Welding Electrodes. Arcos Corp., 2 pp, No. 44822. Data on 11 alloy electrodes for fabrication welding and salvage of both high and low alloy castings. (210)

Self-Locking Nuts. E. A. Bessom Corp., 6 pp. Dimension charts of this company's various types of self-locking nuts. (211)

Welding Cost Calculator. Champion Rivet Co., slide indicator. Shows the costs for welding materials using various types of fillets and joints, and estimates the various factors effecting the costs. (212)

Welding Positioners. Cullen-Friestadt Co., ill. Catalog shows line of hand- or power-operated welding positioners with capacities up to 30,000 lb. (213)

Tool and Die Salvage Welding. Eutectic Welding Alloys Corp., 64 pp, ill. Manual presents complete data on effective tool and die salvage welding procedures. (214)

Solder. Federated Metals Div., 36 pp, ill. Data on the selection of solders for specific applications, their properties and use. Tells the role of fluxes and how to prepare the work. (215)

Joining Rubber-Lined Pipes. Gates Engineering Co., 12 pp, ill. Advantages and specifications of the Gaco rubber-lined pipe joint process of joining and replacing rubber-lined pipe. (216)

Brazing. Handy & Harman, ill, No. 54. "Brazing News" describes applications and developments of Easy-Flo and Sil-Fos low temperature silver brazing alloys. (217)

Effective Use of Locknuts. Industrial Fasteners Institute, 23 pp, ill. Descriptions and principles of operation of representative types of locknuts. (218)

Brass and Bronze Fasteners. The Jacques Co., 26 pp, ill, No. 50. Price lists and specifications of this firm's fasteners, including various nuts, cap screws, bolts and washers. (219)

Weld Design. The Lincoln Electric Co., 5 pp, ill, No. 830B. Outlines basic steps for converting products to steel construction by welding and shows various weldments illustrating their strength and ductility. (220)

Silver Brazing Preforms. Lucas-Milhaupt Engineering Co., 10 pp, ill. Features an interesting article on the advantages of using silver alloy preforms. Includes detailed specifications. (221)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 225

Inert Arc Welding. Metal and Thermit Corp., 8 pp, ill. Advantages and operating hints on inert-gas-shielded arc welding. Also lists welding equipment specifications. (222)

Soldering and Brazing Generator. New Rochelle Tool Corp., 4 pp, ill, No. 1J1797. Advantages, features and specifications of the Type 1-AL electronic power generator for soldering and brazing by the induction method. (223)

Welding Aluminum. Reynolds Metals Co., 186 pp, ill, No. RMC-14. Revised edition of the comprehensive manual covering the welding, brazing and soldering of aluminum. Request direct from Reynolds on company letterhead.

Set Screws. Set Screw & Mfg. Co., 20 pp, ill, No. 16. List prices and dimensional information on a complete line of Setko and Zip-Grip set screws. (224)

Stainless Steel Fastenings. Star Stainless Screw Co., 16 pp, ill, No. 52-A. Offers detailed specifications to aid in selecting and ordering a variety of stainless steel fastenings. (225)

Welding Positioners. Worthington Corp., Industrial Div., 36 pp, ill, No. 210C. Description, features and applications of 100- to 40,000-lb capacity welding positioners. (226)

Forming • Casting • Molding Machining

Machining Stainless Steels. Armco Steel Corp., 37 pp, ill. Lists grades and their description and characteristics. Also give operating instructions, tool compositions and selection charts. (227)

Coated Abrasive. Carborundum Co., Coated Products Div., 8 pp, ill, No. 2. Characteristics and applications of Resin Industrial Cloth, a new coated abrasive product for dry-belt grinding. (229)

Wet-Abrasive Cut-Off Machine. Cincinnati Electrical Tool Co., 2 pp. Description, features, alternating and direct current specifications of this wet-abrasive cut-off machine. (230)

Tool and Die Milling Machine. Cincinnati Milling Machine Co., 19 pp, ill, No. M-1731. Features, design and applications of die milling machines. (231)

Cold Forming Lubricant. Detrex Corp., 8 pp, ill, No. 206-3. Complete data on the Detrex Extrudite Process for the cold forming of steel. (232)

Diamond Finishing. Elgin National Watch Co., Abrasives Div., 8 pp, ill. Basic information on the characteristics of Elgin diamond as an abrasive. Includes specifications. (233)

Government Specification Products. E. F. Houghton & Co., 7 pp. Handy reference listing of Houghton production meeting government specifications. Listing includes specification numbers, description and name of approved Houghton product. (234)

Semi-Automatic Presses. Hydraulic Press Mfg. Co., 4 pp, ill, No. 5107. Gives description and specifications of H-P-M automatic com-

MANUFACTURERS' LITERATURE

pression molding presses for reinforced plastics molding. (235)

Die Casting Machines. Lester-Phoenix, Inc. Folder gives description, features and specifications of this company's die casting machines and injection molding machines. (236)

Machining Hard Metals. The Method X Co., 4 pp, ill, No. SA1018. Features, operation, tolerances and applications of new machine said to facilitate fabrication of sintered carbides, S-816, etc. (237)

Tool Sharpening. Micrometrical Mfg. Co., 4 pp, ill, No. L-22. Advantages and case histories showing how tool sharpening gives more consistent surface finish, longer tool life and savings in time and material. (238)

Tungsten Carbide Compacting Tools. National Carbide Die Co., 4 pp, ill. Discusses various tungsten carbide compacting tools as they are applied to powdered metallurgy. (239)

Precision Metalworking Machines. O'Neil-Irwin Mfg. Co., 32 pp, ill, No. 52-19. Complete data on a variety of Di-Acro precision machines for die-less duplicating. Includes specifications. (240)

Machining Laminated Plastics. Synthane Corp., 6 pp, ill. Recommended techniques for common machining operations on laminated plastics. Includes properties and design hints. (241)

Drilling Machine. Wales-Strippit Corp., 8 pp, ill, No. DM. Profusely illustrates both standard and deluxe models of Wales drilling machines for precision layout, drilling, reaming and boring of holes. (242)

Presses. Watson-Stillman Co., 8 pp, ill, No. 110-C. Features a variety of metal working, extrusion, hobbing and railroad presses, as well as plastics molding machinery, etc. (243)

Adjustable Perforating Dies. S. B. Whistler & Sons Inc. Catalog describes this company's line of adjustable perforating dies for punching holes in sheet metals. Includes prices and applications. (244)

Inspection • Testing • Control

Laboratory Reagents. Allied Chemical & Dye Corp., General Chemical Div., 40 Rector St., New York, N. Y., 264 pp, ill. Complete buyer's guide for users of laboratory reagents and chemicals. Includes such pertinent facts as grades, strength and maximum limits of impurities. Request direct from Allied on company letterhead.

Radium Radiography. Atomic Energy of Canada Ltd., Commercial Products Div., P. O. Box 379, Ottawa, Canada, 71 pp, ill, price $2.00. Detailed theory, equipment and applications of radium radiography. Available directly from Atomic Energy of Canada.

Test Specimens and Microscopes. Adolph I. Buehler, 8 pp, ill. Includes specifications and prices of a complete line of test specimens and miscroscopes for metallurgy. (245)

Photoelastic Stress Analysis. Eastman Kodak Co., 343 State St., Rochester 4, N. Y., 16 pp, ill, price 35c. Booklet briefly discusses photoelastic stress analysis as a method of solving problems of stress distribution. Write direct to Eastman on company letterhead.

Furnace Temperature Indicator. Claud S. Gordon Co., 2 pp, ill. Describes device which quickly indicates any deviation from desired furnace temperature. (247)

Time-Temperature Control. Minneapolis-Honeywell Regulator Co., Brown Instrument Div., 13 pp, ill, No. 6020. Shows features, design characteristics and specifications of cam programmer thermometers. (248)

Universal Testing Machines. National Forge & Ordnance Co., Testing Machine Div., No. 501. Specifications, capacities and operating principle of table model universal testing machines. (249)

Metal Hardness Testers. Newage International, Inc., 4 pp, ill. Advantages of using the Ernst portable metal hardness testers for testing any size, shape or type of metal. (250)

Temperature Control. The Pyrometer Instrument Co., No. 150. Catalog shows Pyro Immersion Pyrometer, accurate instrument for nonferrous foundry temperature control. (251)

Thermocouples. Arklay S. Richards Co., Inc., 16 pp, ill, No. 5. Description, specifications and advantages of this company's thermocouples and thermocouple accessories. Includes information for ordering. (252)

Ultrasonic Thickness Gage. Sperry Products, Inc., 4 pp, ill, No. 3700. Description and basic theory of Reflectogage ultrasonic thickness tester and flow detector. (253)

Temperature-Sensitive Tablets. Tempil Corp., 1 p, ill, No. 5011-P. Instruction sheet gives helpful hints on the use of Tempil pellets, temperature-sensitive tablets of calibrated melting points. (254)

Dye Penetrant Inspection. Turco Products Inc., 10 pp, ill, No. 500C. Outlines the many applications of Turco Dy-Chek and Turco Chek-Spek for discovering dangerous hidden flaws. (255)

Impact Tester. U. S. Testing Co., Inc., 2 pp, ill. Includes history, description and use of the SPI low temperature impact tester. (256)

Hardness Testers. Wilson Mechanical Instrument Co., 44 pp, ill, No. RT-46. Description and features of available Rockwell hardness testers and accessories. Shows operating techniques and principles. (257)

General

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (258)

Decimal Equivalent Chart. John Hassall, Inc. Easy-to-read decimal-equivalent wall chart of this company's cold headed parts. (259)

Materials Controls. Remington Rand Inc., No. KD367. Booklet describes Kardex system for keeping visible materials and parts inventories coordinated with production. (260)

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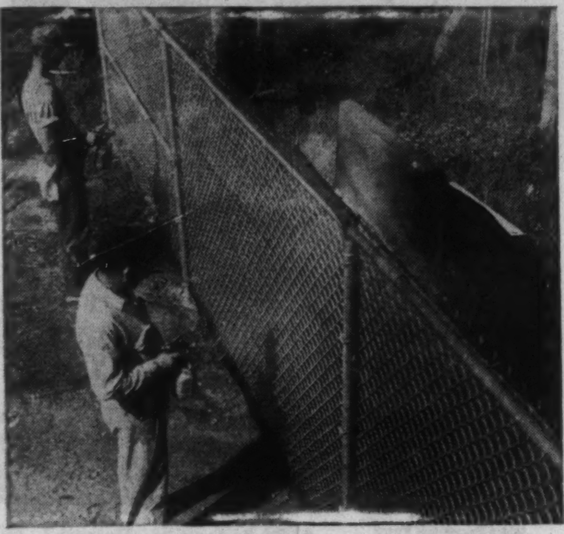

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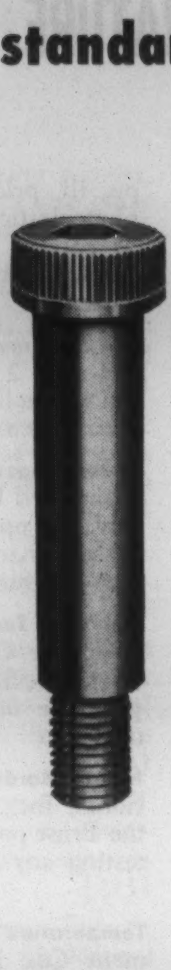

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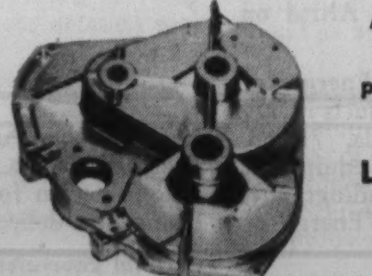

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Reichhold Chemicals, Inc. 128
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Republic Steel Corp., Steel & Tubes Div.... 19
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The Editor's Page

Meet the Press

No, we're not going on television, but we do want you to meet two new members of the press. In this case, it's *Materials & Methods.* Soon you will be seeing two new names on our masthead, so we'd like to introduce the two newest members of our staff. Their names are Malcolm Riley and Theodore Merrill, Jr. Both are young, personable and capable. It's a surprising thing how the University of Michigan maintains a majority representation on our staff. In this case one of the two, Ted Merrill, attended the same school as two of our other staff members. Mal Riley is a graduate of Dartmouth and comes to us from Boeing Airplane Co., where he served as a methods engineer. Ted Merrill comes to us from the *Time* and *Life* empire and will make more use of his engineering and scientific education. In the words of a Navy man, Welcome Aboard.

Hard to Believe

Probably a more charitable soul would let pass a slip such as we are about to report. However, here's how errors are born. Recently a publication dedicated to keeping abreast of industrial and business news each week carried an article on high temperature materials. We'll overlook the fact that ceramals, cermets, ceramics and carbides were referred to as baked tiles. But we couldn't swallow the statement that carbonates are being considered for high temperature service. Aside from the fact that they wouldn't be carbonates if they could resist high temperatures, we doubt if salts and esters of carbonic acid would have much to offer in the way of properties. So, if your top brass tells you to investigate carbonates, you'll know how the mistaken impression was started.

A Tip of the Hat

At the exposition, the booth of *Materials & Methods* received much favorable comment because it departed somewhat from the usual publisher's booth style and attempted to tell something tangible about the magazine. For the execution of a good idea, we tip our editorial hats to John Cunningham, our promotion manager.

Another Welcome

As much as we in the editorial department hate to admit it, advertising is an essential as well as helpful part of any magazine of this type. Thus, goings on in that department should come in for a little comment. The latest development in *M&M's* advertising department is the appointment of a new advertising sales manager. M. R. (for Randy) Long fills the new post and should, by this time, be nicely settled in his new home near Stamford, Conn. Randy has served as a salesman in the Philadelphia and Chicago territories since his discharge from the Navy.

They Liked It

Recently I had an opportunity to study the answers to a questionnaire sent to registrants of the recent Basic Materials Conference. While the answers were varied, an overwhelming majority seemed to favor the whole idea and suggested that many of the topics on this year's program be repeated next year. Out of more than 100 who told what they liked and what they disliked about the conference, there were not more than three that thought the whole thing was a mistake. Certain impressions can be gained from a casual study of the replies. However, the answers which can be analyzed statistically will be so handled and serve as a guide to the next conference, which is scheduled for May, 1954, in Chicago.

Resisting Progress

Laminated materials are finding ready acceptance in many industries. There is still one well publicized hold-out, however. Recently the high moguls of baseball voted down a resolution permitting laminated wooden bats to be used in place of the solid bats which have been used since baseball began. No clear cut reason was given except that no bat except the old one is fit for professional use. Possibly they might have something though, for the combination of a lively ball and a lively bat might make Babe Ruths out of the lowliest of batsmen.

T. C. Du Mond
Editor